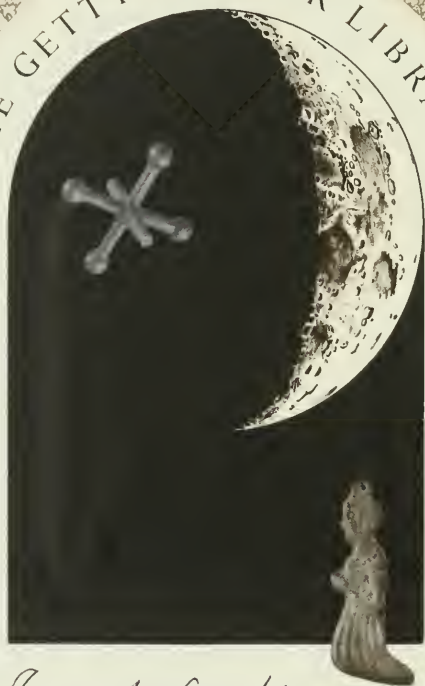




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*Why ask for the moon
When we have the stars?*

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Thalassia et Thalassia







SPECIMEN OF THREE-COLOR WORK.

Engraved and printed by the Chicago Colortype Company, 1205-1213 Roscoe St., Chicago.

Illustrations by J. C. Smith

A MANUAL
OF
PHOTO-ENGRAVING

CONTAINING PRACTICAL INSTRUCTIONS
FOR PRODUCING

PHOTO-ENGRAVED PLATES

IN

RELIEF-LINE AND HALF-TONE

WITH

CHAPTERS ON DRY PLATE DEVELOPMENT AND
HALF-TONE COLOR WORK.

By H. JENKINS.

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THE INLAND PRINTER COMPANY.
1896.

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PREFACE.

IN preparing this work, it has been my aim to present such information that a person inexperienced in photographic operations might be enabled to obtain from it an intelligent conception of the methods used for making line and half-tone engravings.

If therefore details have been entered into which may to some seem superfluous, it should be remembered that what may appear self-evident to the expert may often be perplexing to the novice unless clearly explained.

While entering thus into detail regarding the processes treated of, I have avoided the discussion of obsolete and untried methods, and have endeavored to make the descriptions as brief as possible without sacrificing clearness.

The methods described are those used in the regular engraving establishments, and I believe that with careful study and properly directed effort, the beginner will obtain satisfactory results.

In addition to the chapters devoted to the engraving processes I have prepared a chapter on the development of the gelatine dry plate, as a work of this nature would seem incomplete without some information on that subject.

The excellent photographs from which a number of the half-tone plates were made were the work of Mr. A. C. Pack, of the Randall studio, Ann Arbor.

H. JENKINS.

CHICAGO, October 1, 1896.

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MANUAL OF PHOTO-ENGRAVING.

CHAPTER I.

INTRODUCTORY:

A COMPARISON of the periodicals of several years ago and those published today reveals to the observer a marked difference in the number and quality of the illustrations. In the former we find but few cuts, and those engraved on wood, often in an indifferent manner. In the magazines and newspapers of the present, however, nearly every page exhibits one or more illustrations of most artistic character.

While wood cuts are still used to a considerable extent for general illustrative purposes, the majority of the engravings are at present produced by the now well-known processes of engraving by aid of photography. The several advantages which photo-engraving possesses over wood engraving have created a demand which has steadily increased and opened avenues of employment to many who have taken up this branch of work as a profession. A cut which formerly would have required several days to produce can now be turned out in a few

hours, and will have reproduced all of the features of the original copy to exactness, while its cost is but a fraction of that for wood engraving.

While there are several methods of engraving which depend upon photography for their existence, the term "photo-engraving" is usually applied only to relief plates in line and half-tone, and to a description of this class of work the following pages will be devoted.

To the inexperienced, photography often seems to be a mysterious and difficult art, but the manipulations described hereafter will with proper study become remarkably simple when the results attainable are considered.

The production of a photo-engraved plate includes several stages as follows:

1. The making of a negative.
2. The printing of the image on the metal.
3. The etching.
4. The finishing and blocking.

In regular establishments separate departments are devoted to each branch, every employe being a specialist in his line.

A description of the details which are included in each of the various stages will, however, be given, that the reader may obtain a general knowledge of the art.



HALF-TONE — 150-LINE SCREEN.

CHAPTER II.

THE APPARATUS REQUIRED.

THE apparatus required for making photo-engravings will vary in completeness with the amount and quality of work to be turned out. For the experimenter or the establishment which devotes but a small department to the work, an equipment of high grade and large capacity would be out of the question. For large shops, however, which are established with a view to commanding a large patronage, where rapidity of production and a uniformly excellent quality of work are important matters of consideration, it is essential that the apparatus be of the most approved pattern, and that each department be fully equipped.

The capacity of the apparatus should be determined by the size of plates demanded. The average engraving establishment will find an equipment for producing plates 14 by 17 inches in dimensions ample. The demand for half-tone plates is usually for sizes under 10 by 12 inches, and many shops are not provided with facilities for plates larger than that size. Line plates are also, as a rule, of dimensions smaller than this, but provision should be made for work of as large dimensions as the funds available will permit, and the prospective order may require.

The article of the greatest importance, in connection with the outfit, is

THE LENS.

This should be selected with a view to its fulfilling the special requirements of this class of work. It should be of the rectilinear type, so that all straight lines in the copy will be reproduced without distortion. It should cut clearly all portions of the copy, and its design should be such that it may possess rapidity. There are several lenses on the market which fulfill these requirements—the Rapid Rectilinear Dallmeyer, the Steinheil and Swift being popular among operators.

THE CAMERA.

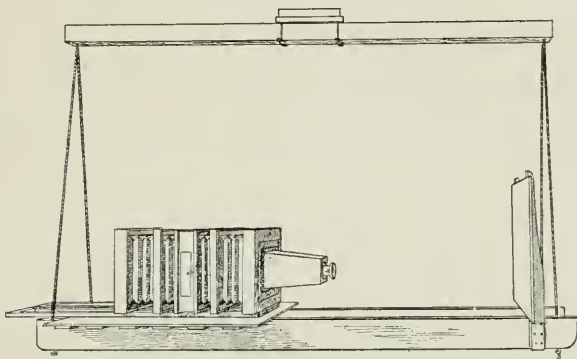
In selecting the camera it is advisable to obtain the form known as the enlarging, copying and reducing camera, as its construction possesses several advantages over the ordinary copying camera.

For half-tone work it should be provided with the adjustable screen plateholder, which enables the kit to be dispensed with for holding the screen and sensitive plate. It is so constructed that the separation of screen and plate can be adjusted accurately and easily to any desired degree, and different sizes of screen and plates can be used.

This plateholder has displaced the kit in all leading shops, but for those who may desire to use the kit, details of construction will be given further on.

CAMERA STAND.

The camera should be provided with a stand, which may be in the form of a long table or bench to stand on the floor, or it may be swung from the ceiling, this condition being necessary if the building is subject to vibrations from the running of machinery or other causes. It consists essentially of an oblong frame upon which the camera will



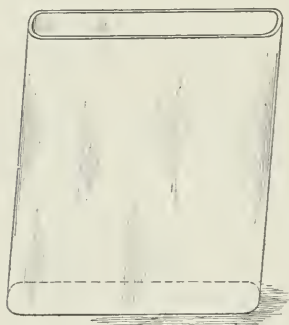
CAMERA AND SWING

slide readily, the frame being suspended from a beam of the same length, ropes or strips of metal running from the ends of the beam and attached to each end of the frame in an inverted V shape. The beam being suspended from the ceiling, carries the frame upon which the camera is placed. At one end of the frame the copy board is fastened, and should be in a position perpendicular to the bed, and should be arranged to slide from right to

left when desired. The length of bed will vary according to the capacity of the camera. For a 10 by 12 camera, ten feet; 11 by 14, twelve feet; and for a 14 by 17 camera fourteen feet are good proportions. Such a bed can be easily constructed of ordinary scantling, or can be purchased from dealers in photo-engravers' supplies.

SILVER BATH.

The silver bath is almost invariably kept in a glass vessel of special form, which, when holding



SILVER BATH.

the bath for use, should be kept in a "light-tight" box, with a cover.

It is important that a bath of ample capacity be provided, as such a one will require less attention than a small one and save the operator annoying delays. In all well equipped shops two or more baths are provided for each operator,

that one may be used while another is being rectified.

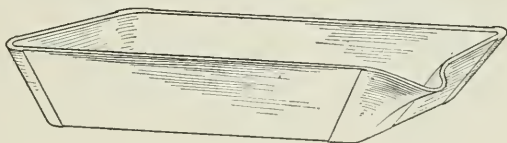
EVAPORATING DISH.

For evaporating the alcohol from the bath, a porcelain evaporating dish is required. It should be of ample capacity to hold the silver solution from the bath, with room to spare. As an accessory, it

is well to have an iron dish to hold sand in which the porcelain dish can rest while heating.

TRAYS.

For line etching there should be one or more large trays or "tubs" so arranged that they may rock at the will of the etcher. These tubs are

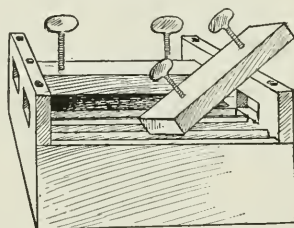


TRAY.

made of wood, sealed water-tight and usually protected by a coating of impermeable varnish. For developing prints on zinc, any ordinary sheet metal tray will serve the purpose. For half-tone etching porcelain or rubber trays may be used.

PRINTING FRAMES.

For printing on metal there are special frames, so constructed that equal contact with the negatives can be obtained for all parts of the metal plates. For making silver prints the ordinary photographer's printing frame is used.

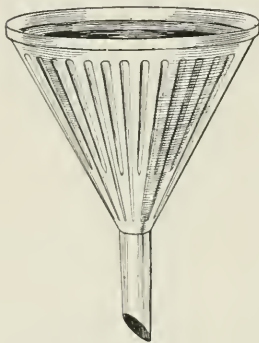


PRINTING FRAME.

GLASSWARE.

For measuring solutions, several graduates of a capacity of from eight to sixteen ounces each

should be purchased. There should also be a large funnel for filtering the baths and several smaller ones for collodion, printing solutions, etc.



FUNNEL.

An important article is the actino-hydrometer for testing the strength of the silver bath.

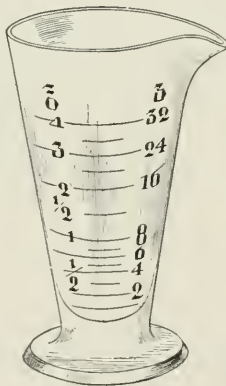
Various sizes of plate glass, as required, should be provided for negative making and for turning negatives upon. For the latter purpose the glass is usually obtained of one-fourth inch in thick-

ness, to more readily stand the pressure in the printing frame.

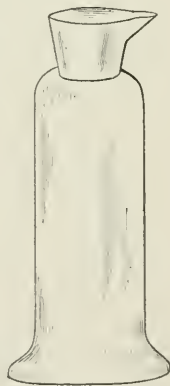
Vials for holding collodion, large bottles for filtering the bath into, and smaller ones for solutions are also necessities.

ROLLERS.

For inking line plates, composition rollers are used. These should be of the kind known as "hard" rollers, as they more readily take and distribute the ink.



GRADUATE.

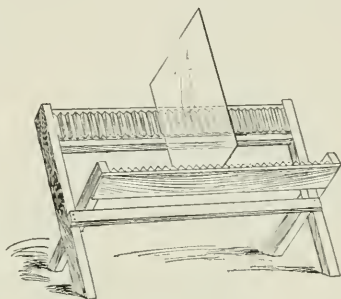


COLLODION VIAL.

An excellent roller for this purpose can also be made from white rubber, such as is used for clothes wringers. For inking the plate after etching, a leather-covered roller is usually used.

MISCELLANEOUS ARTICLES.

Besides the articles described above, there are other essentials, as follows : Gas stoves, for heating and drying plates ; squeegees, for smoothing down negative films—these are simply strips of white rubber fastened to a strip of wood ; scales, for weighing dry chemicals ; negative racks ; brushes for etching—bristle for line etching, and soft for half-tone ; inking slab for rolling ink upon—a smooth sheet of stone, zinc or glass will answer the purpose ; pliers, for holding plates while burning in ; zinc hook, for cutting zinc plates ; small camel's-hair brushes, for spotting and painting in on plates ; egg beater ; hammers ; nails ; scraping tools, for cleaning spaces on zinc ; engravers' tools, for tooling plates after etching ; files, for smoothing edges of metal ; calipers, punches, etc.



NEGATIVE RACK.

MACHINERY FOR FINISHING.

For a well equipped shop there are several machines which are essential. Small concerns are

often operated with but a small equipment of machinery, but for large establishments the outfit of necessary machinery is in many cases a very extensive affair.

The routing machine is the most important item in this department, and is used for deepening and cleaning out the spaces in zinc etchings, making a bevel around half-tones, etc. These machines can be obtained in various sizes according to the dimensions of plates to be routed.

A circular saw is also an essential piece of machinery, for sawing metal plates, blocks, etc.

The trimmer, as its name indicates, is used for trimming the edges of blocks after the plates are mounted.

The shoot board is used for a similar purpose and is generally substituted for trimmer in small shops.

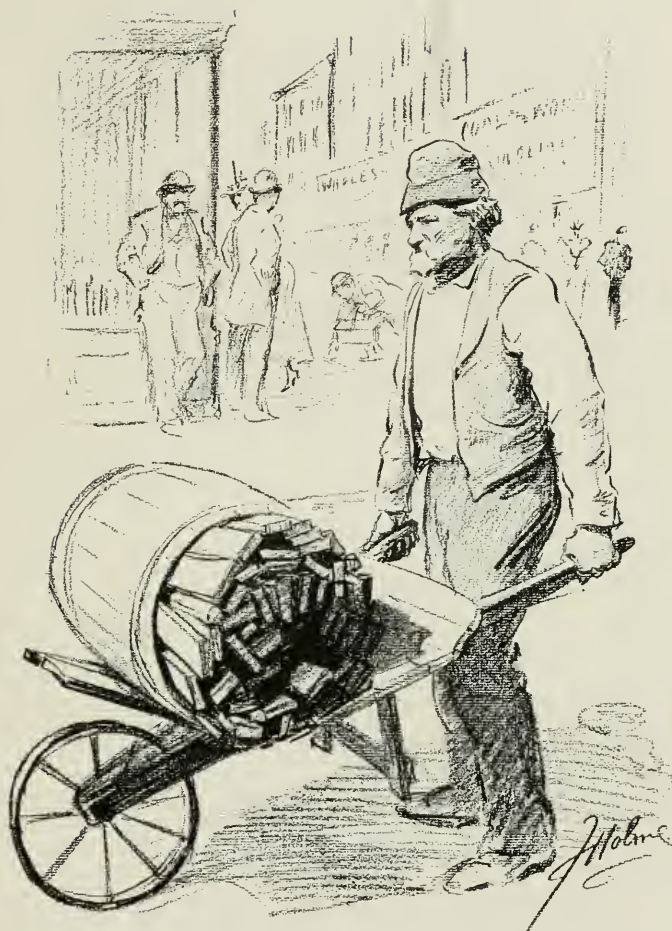
The Daniel's planer is used for making mounted blocks type-high. It is an expensive machine, and for small establishments the shaving machine operated by hand can be used instead.

A drill is often of use for various purposes, and is necessary in mounting half-tone plates from the back.

The beveling machine is used for beveling the edges of plates.

The buffing machine is used for polishing metal. It is not found, as a rule, in small shops, as the metal can be polished by hand.

For taking proofs, a printing press is required, and for the engraving establishment the hand press



ZINC ETCHING—CRAYON EFFECT.

From sketch by Frank Holme.

known as the "Franklin" or "Washington" type is best.

The mounting slab is simply a smooth-surfaced block of iron upon which the cuts are placed when being blocked.

A detailed description of the above mentioned machinery is not given here, on account of the various designs on the market, and as manufacturers are always ready to send to inquirers descriptions of all latest improvements.

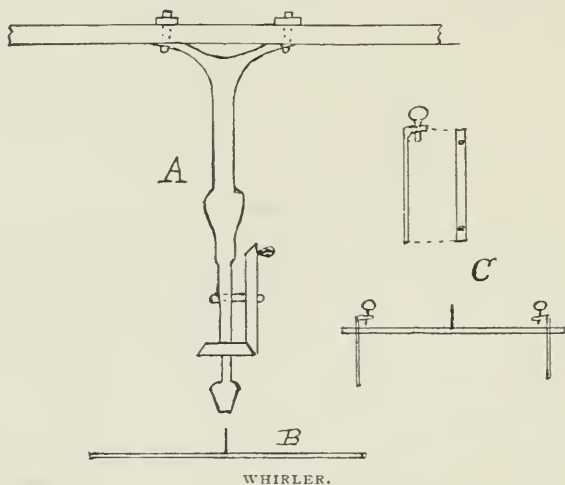
THE WHIRLER.

In coating plates for half-tones with the enamel solution it is necessary, in order to obtain an even coating, that a rapid whirling motion be given while the solution is in the fluid condition on the plate.

A number of devices can be used for this purpose. A common form, sold by the supply houses, consists of a handwheel mounted in a horizontal position on a board and connected by means of a belt with a table similarly mounted at the other end of the board, the table being provided with clamps to fasten the plate. Upon revolving the handwheel the table is caused to revolve also, thus spreading the solution in an even coating over the plate.

A much better whirler, however, can be constructed by means of an ordinary drill stock, as follows: To the bottom of a shelf placed at a convenient height fasten the drill stock as shown in Fig. A. Then at a machine shop obtain a

strip of iron about three-fourths of an inch or an inch in width, one-sixteenth of an inch in thickness, and twelve or fifteen inches long, and to its center have fastened a round stem. Fig. B. Also have made two strips about four or five inches



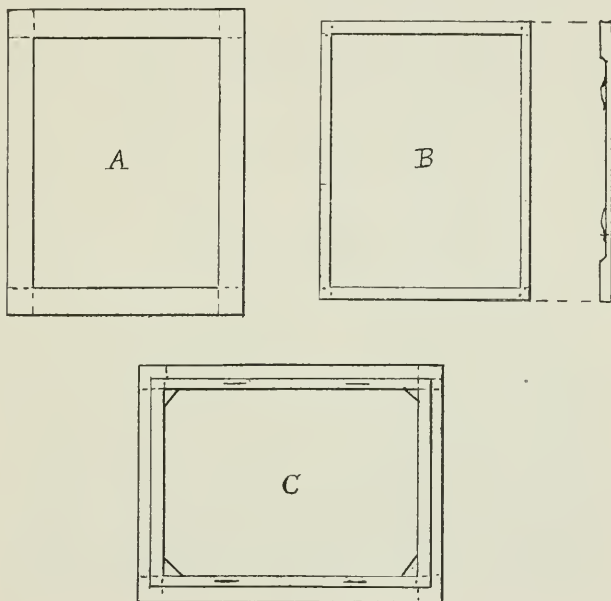
long with apertures cut at each end, those at one end of a size and shape to admit the ends of the other strips. Have one of the ends of each of the latter strips bent over, and a hole drilled to admit a thumbscrew, as shown in the cut, Fig. C.

The long strip is fastened in the chuck of the drill by means of the stem and the two short strips are slipped over the ends, as shown in Fig. C. A gas stove should be placed under the whirler to warm the plate and accelerate the drying of the coating.

The use of this whirler will be explained in a later chapter.

THE KIT.

Before the advent of the plateholder mentioned in a preceding paragraph, the kit was used by operators to hold the screen and sensitized plate during exposure, and is yet used by those who do not wish to incur the extra expense of the holder.



KIT.

The kit is simply a rectangular frame so constructed that when placed in the plateholder of the

camera the negative plate will occupy the position of the ground glass and the screen be held in front of it. Its construction can be understood by an examination of the illustration. A is a frame made of strips of cherry, walnut or other suitable wood, about one inch wide, one-eighth inch thick and of lengths required by the size of screen. The ends should be mortised and glued strongly together. On the opposite side of this frame is fastened a second frame of strips, one-half inch wide and one-fourth inch thick, and so placed that the inner edges of this frame will be flush with the inner edges of the other. The ends of this second frame should be fastened in a similar manner to those of the first. To the longest sides of this second frame should be fastened springs, which may consist simply of elastic curved strips of brass or steel, the springs being fastened at one end so that they can be moved so as to allow the other end to press upon the screen when in position. These sides of the second frame should be thin in the center so that the springs will not interfere with the slide. Across the corners of the kit between the frames of which it is composed are placed four corner pieces to separate screen and plate. These are often of silver but may also be made of wood, and should be no thicker than to prevent contact of screen and plate, and should be set into the first frame so as to be flush with the side next the second frame.

In the diagram, A represents the first frame; B, the second, with a view of one edge of the sides



HALF-TONE — 120-LINE SCREEN.

containing the springs; C, the kit complete, with corners.

The kit should be made of a size to readily admit the screen used, negative glass of the same size being used also. It should be thoroughly covered with shellac varnish, to prevent the silver destroying the wood.

The use of the kit will be explained in the chapter on half-tone negative making.

THE SCREEN PLATE.

The screen plate is, of course, absolutely necessary in half-tone negative making. The size obtained should be governed by the size of the half-tone plates which the establishment expects to make.

The description of the screen and its uses will also be given in a later chapter.

CHEMICALS.

The chemicals required for making the collodion negatives and for the etching operations are as follows:

Alcohol (grain).	Iron sulphate (ferrous).
Alcohol (wood).	Iron perchloride.
Ether (sulphuric).	Potassium permanganate.
Gun cotton.	Iodine.
Ammonium iodide.	Silver nitrate.
Cadmium iodide.	Turpentine.
Potassium iodide.	Ammonia (strong).
Potassium bromide.	Castor oil.
Potassium cyanide (fused)	Ammonium sulphide.
Ammonium bichromate.	Eosine.
Strontium chloride.	Le Page's liquid glue.

Calcium chloride.	Rubber cement.
Mercuric chloride.	Transfer etching ink.
Ammonium chloride.	Lye.
Acetic acid.	Dragon's blood.
Nitric acid (Com.).	Sodium bicarbonate.
Nitric acid (C. P.).	Absorbent cotton.
Chromic acid.	Charcoal blocks.
Copper sulphate.	

Ordinary charcoal will not answer the purpose of polishing the metal. The most suitable is that used by jewelers for soldering purposes and is obtained in blocks of about 3 by 4 inches.

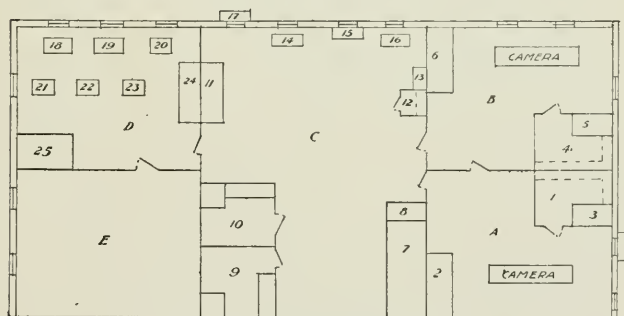
To insure success most of the chemicals mentioned above should be chemically pure. They should be kept in bottles corked or stoppered to prevent evaporation or deterioration. The bottles should be plainly labeled to prevent errors when the contents are wanted for use.

CHAPTER III.

SHOP ARRANGEMENT.

IT is a difficult matter to prescribe a set plan for the arrangement of a photo-engraving establishment, as there is such great variation in the size and relative positions of rooms which may be selected for occupation, and as large shops require more extensive accommodations and special features which need not enter into the equipment of smaller concerns.

There are general principles, however, which can be applied in fitting up any shop, and the



SHOP ARRANGEMENT.

accompanying diagram is given to represent an arrangement for a shop of moderate size.

THE OPERATING ROOMS.

A is the room for the half-tone, and B for the line operating. One room is often used for two or more cameras, but it is advisable, if possible, to provide separate apartments for the cameras, thus avoiding interference of one operator with another. 1 and 4 are the darkrooms. These may be constructed with walls of ordinary flooring joined to be light-tight. They should contain sinks 3 and 5, over each of which should be placed a tap for washing the negatives. At the right of the sink there should be placed a shelf for holding the bottles of developer and other solutions. Other shelves should also be provided for holding stock solutions, and other accessories. Above the sink there should be a window containing a light of orange glass, and arranged to slide open readily at the will of the operator. If dry plates are to be developed, arrangement should be made to close up the yellow light and substitute the ruby light required for dry-plate work.

The silver bath should be placed in a receptacle at the back of the darkroom, the bath holders being placed at such a level as to permit the convenient lowering of the plate into it. Above, or at one side of the silver baths, a shelf should be located upon which the plateholder can rest.

The darkroom should be of dimensions large enough to give ample room, and should be free from cracks and openings through which light might pass. 2 and 6 are benches for holding negative racks and other articles.



VIGNETTED HALF-TONE—175-LINE SCREEN.

From wash drawing by C. W. Traver.

The location of the cameras should be such as to be convenient to the darkroom, and they should be swung at a height to be most convenient for the operator to manipulate.

The illumination of the copy is an important factor in producing negatives, and provision should be made for obtaining the best facilities. The light can be obtained either from a skylight, or by means of electric lamps. In many shops both means are provided, the light being obtained from the skylight during the bright hours of the day, and from the lamps at other times. The skylight should be as large as convenient, to furnish an ample volume of light. The lamps should be arc lamps, and should be swung, one on each side of the camera stand, near the copy board, in such a manner that they may be readily raised or lowered. They may, if desired, be arranged with movable stands, instead of being swung. Two lamps should be used, as a more uniform illumination can be obtained from two than from one, and reflections are avoided. The lamps should be wired to burn independently of each other, and the current furnished should be uniform, to prevent, as far as possible, flickering and variation in the intensity of the light. Reflectors are generally used to concentrate the light on the copy, and are of various forms. One can be made readily from an oblong piece of tin, by bending it to make its section semi-circular, the edges being bent to fit around the sides of the lamp. The inner surface may be painted white, or, better, etched off with nitric

acid, which will prevent reflections being cast on the copy.

A shelf should be built outside of one of the windows to give facilities for sunning the silver bath. A gas stove should be placed on one of the benches, for evaporating the bath, heating negatives, etc.

ETCHING ROOM.

C is the etching room, which for convenience is located next to the operating rooms. 7 is a sink of ample capacity where the metal may be polished, glass washed, and negatives turned. 8 is a shelf for holding glass and other articles. 9 and 10 are rooms for sensitizing metal, one being designed for line and one for half-tone work. They should be furnished with benches, shelving, and gas stoves. The illumination should be subdued, to prevent the action of light on the plates before printing, but not to such an extent as is necessary for the darkrooms for negative making.

The construction, arrangement, and care of these rooms should be such as to prevent the accumulation of dust, which will cause spots in the coating of the plates. This remark will also apply to the darkrooms, 1 and 4.

In the room used for coating the line plates a bench and slab may be provided for rolling up the plates. 11 is a bench for general purposes, such as cutting zinc upon, holding negatives for printing, etc. 12 is the powder box to contain the dragon's blood for the line etchings. In some shops an

open box is used, but it is better to have a closet built around it to prevent the powder from being carried about the room. 13 is a bench for a gas stove for burning in the plates. 14 and 16 are etching tubs, placed near the windows, to obtain ample light. 15 is a sink or a bench to hold a tray of water to rinse the plates after etching. 17 is a shelf placed outside of the window for printing by daylight. An electric lamp should also be provided for the printing.

THE FINISHING ROOM.

D is the finishing room in which numbers 18 to 23 represent the several machines. 24 and 25 are benches for mounting the plates upon, for holding tools, material, etc.

The machinery should be operated from a line of shafting which should be provided with belt shifters, that any machine may be started or stopped as desired. If the building is equipped with a power plant the shafting may be operated by a belt running from some other line. If the place is not thus equipped the power may be obtained from a gas engine or electric motor.

E represents the office.

In large establishments the half-tone etching is often done in a room separate from that used for line etching, but such an arrangement need not be considered as necessary.

In selecting a location for a shop it is important to obtain one where there will be an ample supply of running water at all times and where there are

a number of windows, as it is desirable to have plenty of light.

In fitting up the shop economy should sometimes be sacrificed to completeness and convenience, as future results may at times justify an outlay which might at first seem to be extravagant.

The above description is intended to give only general directions for the shop arrangement. Special situations will require various departures from this plan.

CHAPTER IV.

NEGATIVE MAKING.

GENERAL PRINCIPLES — CHEMICALS.

THE production of a photographic negative, as described hereafter, depends upon the fact that certain salts of silver are so acted upon by certain of the component rays of white light as to be changed in structure. The salts which have been found to be thus sensitive are the iodide, bromide and chloride of silver, each producing results somewhat different from the others and being often combined in certain proportions to obtain the qualities of all in the resulting negative. As intimated above, not all of the rays which together form white light are effective in making a change in these silver salts, and it is this condition also which renders photography possible, for the compounds can be prepared for use in a room from which the "actinic" rays (as those which affect the salts are called), are excluded, the plate being afterwards properly exposed to the action of the "actinic" light, and the operation is then completed by the aid of the "non-actinic" illumination.

For convenience, it is customary (and, in fact, essential) to use some substance to hold the salts and form a film over the surface upon which the

negative image is to be produced. Collodion and gelatine are the substances now universally employed for this purpose in practical work. It is not customary in making the sensitive plate to add directly to the collodion or gelatine the required salts of silver. It has been found to be more advantageous to mix with these solutions the corresponding salts of other elements, and then submit them to the action of nitrate of silver, which will cause the desired sensitive salts of silver to be formed and leave the nitrates of these elements as a by-product, which in certain cases is removed by washing or precipitation. For instance, if we use bromide of ammonium, the action of the nitrate of silver will be to form bromide of silver and nitrate of ammonium, and as stated above, the nitrate is merely a by-product, having no value as a sensitive agent. In the wet collodion process we prepare an insensitive solution, containing the proper salts, and use this solution to form a film upon which the silver nitrate is afterwards allowed to act to form the sensitive salts of silver, the collodion acting merely as a support to hold the salts. In the gelatine process the silver nitrate is added to the solution, thus directly forming the sensitive compounds within it, which, being held suspended in a finely divided condition, are said to be in a state of emulsion.

If, now, we have spread over a plate of glass, or other suitable substance, a coating in which the sensitive salts of silver have been formed, we will have a film which, upon exposure to light containing



ZINC ETCHING—ORDINARY OUTLINE NEWSPAPER CUT.

From drawing by A. B. Shults.

actinic rays, will have certain changes produced in its sensitive constituents. If the whole plate is exposed, it is evident that the change will be uniform over the whole surface, but if only certain portions are exposed, the change will take place in only those parts and the intensity of the change will be proportionate to the intensity of the action of the light upon them. If, therefore, such a plate is exposed in a camera properly focused upon some object, the rays of light reflected from the object will affect the sensitive salts in the film and produce an image corresponding in its parts to the various portions of the object. If, however, the plate is examined after exposure, there will be no *visible* image to be detected. The appearance will be exactly the same as it was before exposure. To bring out the image it is necessary to treat the impressed salts with some substance which will so act as to cause metallic silver to be deposited upon the affected portions. This process is termed "development," the agents employed being called "developers." Various compounds are used for the purpose, such as pyrogallol, eikonogen, ferrous oxalate and ferrous sulphate, the latter being used in the development of collodion wet plates. When a collodion wet plate is acted upon by the developer, the free silver nitrate which remains upon the surface of the plate is decomposed, the metallic silver being deposited upon the impressed portions of the film. While in the emulsion the silver salts are themselves decomposed.

The developers are invariably used in the form

of a solution, and when flowed over the surface of a plate those parts of the image which correspond to the white parts of the object appear first, then the parts corresponding to the half-tones, and finally the details in the shadows. The light reflected from the whites most strongly affect the film, and therefore the deposit of silver will be most dense in those parts of it which correspond to the white portions of the object, the deposit in other portions being dense in proportion to the effect of the light reflected from the corresponding parts of the object, while those parts of the film upon which the blacks are produced will be unaffected, as the black portions have practically no actinic effect upon the silver salts.

The process of development has an important place in the production of the negative, for any carelessness or ignorance in manipulation may ruin what with proper treatment might result in a negative of excellent quality. In the wet collodion process the developer is simply flowed over the plate as it is held in the hand, the operation being simpler and more mechanical than the development of the gelatine plate. In the development of a gelatine negative the plate is placed in a tray and the developer allowed to act until the desired effect is obtained, it being necessary to vary the proportions of the developer if the plates have been over or under exposed.

After the negative has been developed, those parts which have not been acted upon by the light will retain the same appearance that they had

before development, and as the un-reduced salts are of no value they must be removed. To accomplish this the plate is treated with a solution which will dissolve out these salts, and the negative is then said to be "fixed." The substances usually employed to fix a negative are cyanide of potassium or hyposulphite of soda, in solution. The action is a chemical one, the corresponding salt of silver being formed and dissolved in the solution containing an excess of the fixing agent. The result is that we have an image on the plate, dark in the portions corresponding to the high lights of the object, with practically clear glass in the parts corresponding to the blacks, and if the object is one with intermediate tints or half-tones, there will be gradations in the negative to correspond.

To be of use in photo-engraving the negative must be very intense, that is, the parts affected by light must be opaque, while the lines must be as clear glass. This result is obtained by a further treatment of the film after fixing, and the method will be described in the next chapter.

Upon the time which the plate is exposed in the camera depends to a great degree the quality of the resulting negative. The best results are obtained only when the exposure has been of a duration of time suited to the conditions. The area of diaphragm, amount of reduction of copy, intensity of illumination, etc., each has an influence in determining the necessary time.

In making negatives for photo-engravings the wet collodion process is at the present time almost

universally employed, although some excellent results may be obtained with dry plates made for the purpose. In the wet process the plate is made by flowing over a sheet of glass a collodion containing in solution certain iodides, bromides, or chlorides, or combinations of such salts. The plate is then subjected to the action of silver nitrate in solution, which causes the sensitive silver salts to be formed as explained above. The plate is exposed and developed while wet, and if the manipulations are properly carried out the most desirable results can be obtained.

THE COLLODION.

Various formulæ for the collodion can be employed, but the following, which is known to many operators, is one of the best, and is an excellent one for either line or half-tone work :

Alcohol.....	8 ounces
Ether.....	10 “
Iodide of ammonium	30 grains
“ “ cadmium.....	50 “
Chloride of calcium.....	10 “
“ “ strontium.....	10 “
Gun cotton.....	80 “

Either of the chlorides may be omitted. The gun cotton should be easily soluble. Anthony's Red Label is recommended.

To prepare the collodion dissolve the gun cotton in the ether and six ounces of the alcohol. Then put the remaining two ounces of the alcohol in a clean mortar and add each salt separately, and grind with the pestle until dissolved. After all of



HALF-TONE—150-LINE SCREEN.



the salts have been added and dissolved, pour the solution into the solution of gun cotton and shake well. This collodion will usually be found to work well in a few hours after making, but should it fail to work clearly add a few flakes of iodine to turn toward a red color. Before using, the collodion should be filtered through a tuft of absorbent cotton placed in the neck of a clean, dry funnel which should be provided for this purpose alone. The collodion bottle should also be kept tightly corked, as the ether rapidly evaporates, leaving the collodion thick.

THE SILVER BATH.

To prepare the silver bath, dissolve crystals of silver nitrate in water until the actino-hydrometer will, when floated in it, register 40. Distilled or clean rain water should be used if obtainable, but ordinary water as obtained from the faucets can generally be used. In any case the bath after mixing should be placed in the sun for a day or two until it becomes perfectly clear, as any organic matter will be acted upon by the nitrate and be precipitated. After sunning, the bath should be carefully filtered, and, in order that it may give clear images, a few drops of pure nitric acid added until blue litmus paper will be turned red if placed in the solution.

The bath is now placed in its holder, but must be "iodized" before good results can be obtained with it. If a collodionized plate is sensitized in it now, the plate when taken from the bath will look thin and be of a light bluish color, and will give a weak,

thin image. This is due to the fact that in a fresh bath the silver salts when formed in the film are dissolved out by the silver solution. To prevent this the bath must be supplied with iodides. The best method is to place in the bath a collodionized plate as large as the holder will take and let it remain several hours until the salts are dissolved out of its film into the bath. If necessary, this operation should be repeated, until the plates when taken from the bath will have a rich, creamy appearance, and give images of the desired strength. The methods for caring for the bath solution will be given in Chapter VII.

THE DEVELOPER.

The developer for these plates is a solution of ferrous sulphate, which may be dissolved in various proportions. The following will be found to give good general results :

Ferrous sulphate	4½	ounces
Acetic acid.....	3 to 3½	"
Water.....	48	"
Alcohol.....	2½	" or q. s.

2 ¹/₄
1 ³/₄ 24
1 ¹/₄

The crystals of iron should be finely ground in a mortar and then thoroughly dissolved. The developer may be made up by measuring its strength by the hydrometer, in which case it should register 20, and to each 20 ounces there may be added 1½ ounces acetic acid, and alcohol in sufficient quantity to make the solution flow readily. The action of the sulphate is to reduce the silver, as explained in a preceding paragraph, the acid being used to retard its action and keep the image clear. Were

the iron allowed to act alone it would cause a rapid reduction over the entire plate and veil the image. The alcohol is used to cause the developer to flow readily over the plate, for after the bath has been used for a time it takes alcohol from the plates, causing the developer to flow in streaks, the addition of alcohol to the developer aiding it to flow in an even sheet.

FIXING SOLUTION.

Cyanide of potassium. Water.

Make in solution strong enough to dissolve the unreduced salts. Some operators use a saturated solution, others prefer to use it more dilute. Hypo-sulphite of soda may be substituted for the cyanide, but the cyanide is recommended.

INTENSIFYING SOLUTIONS.

There are several methods of intensifying negatives, but those most commonly used are the copper and silver and the mercury intensifiers. The former is generally favored.

COPPER AND SILVER METHOD.

1. Make a saturated solution of copper sulphate, and also one of bromide of potassium.

Place some of the copper solution in a wide-mouthed bottle, and add to it some of the bromide solution. Exact proportions are not necessary. One part of the bromide solution to six or eight parts of the copper will be about right. In making the saturated solutions, it is well to use warm water, as the salts will more readily dissolve.

2. Nitrate of silver. Water.

Make a solution about 25 grains of the silver to the ounce of water. It is not necessary in practice, however, to measure the quantities exactly. The operator will generally place a few crystals in the bottle and dissolve in some water, adding a few more crystals if the solution acts too slowly.

3. Nitric acid. Water.

Make weak solution. About one part acid to eight or nine parts water.

4. Ammonium sulphide. Water.

One part of the sulphide to about five or six parts of water, to which a few drops of ammonia may be added. Keep this solution covered.

MERCURY METHOD.

Mercuric chloride. Water.

Make a saturated solution. Some ammonium chloride is usually added to cause greater saturation.

In connection with this solution, solutions 3 and 4 given above are used.

CLEARING SOLUTION.

1. Place some iodine crystals in a bottle with some crystals of iodide of potassium and add enough water to make a deep red solution. The quantity of iodide need not be as great as the quantity of iodine used.

2. Cyanide of potassium. Water.

Make a very weak solution.

This solution is most readily prepared by taking a small quantity of the stronger fixing solution, and diluting it largely with water.



ZINC ETCHINGS—FROM PEN DRAWINGS, GREATLY REDUCED.

Drawn by A. Cambensy.

CHAPTER V.

NEGATIVE MAKING—LINE NEGATIVES.

IN making negatives, the operator cannot exercise too much care in every detail. The experienced hand knows too well that often carelessness in what might seem to the uninitiated a trivial matter may result in failure.

CLEANING THE GLASS.

The glass upon which the negative is to be made must be scrupulously clean. To provide for this there should be obtained two tubs, large trays, or jars, into one of which a strong solution of lye should be placed, and into the other a quantity of nitric acid diluted with water. The glass should first be allowed to soak for hours in the lye until any particles of matter adhering to it are destroyed or loosened. It should then be taken from it, washed well to remove the lye and any dirt from it, and placed to soak in the acid. When removed from the acid it should be washed again and placed in a negative rack to drain, or if desired for immediate use it may be dried by rubbing with a clean towel, and afterward with a piece of soft cotton cloth. Before collodionizing it should be carefully

dusted with a camel's-hair brush, to remove any specks which might enter the bath or cause spots in the film. A number of plates should be cleaned at a time and kept in a negative rack for use. Some operators albumenize the glass by flowing over it after washing a solution of 1 ounce albumen in 8 or 10 ounces water, acidified with nitric acid. The glass, after drying in a rack, is put away with the albumenized sides all one way. Such glass does not require an edging of rubber before collodionizing.

FOCUSING.

Care should be exercised in focusing to obtain absolute sharpness of the image on the ground glass, as any blurring of the lines will render the negative practically useless. Fasten the copy to the board so that the image will occupy the center of the ground glass, put a large stop in the lens, and move the camera until the image, when perfectly sharp on the ground glass, is of the size desired. In general, the focusing should be done upon that part of the copy about midway between the center and the edge, particularly if the copy is one of large dimensions.

The lights should be so placed that the illumination of the copy will be as uniformly distributed as possible. In photographing large copies by the electric light, it is sometimes advantageous to move the lights during exposure, to obtain an even illumination over the whole. In photographing tracings or line drawings on thin paper, a sheet of white

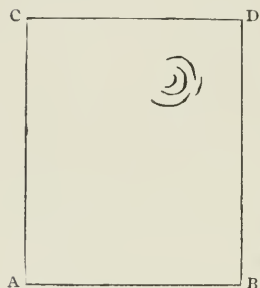
paper should be placed back of the copy. Copy which is crumpled, or which cannot be made to lie flat on the copy board, may be placed in an ordinary printing frame and photographed through the glass. The cover glass in such a case should be clear and well cleaned.

A small magnifying glass is often of service in focusing to examine the lines of the image, especially if the ground glass is of coarse grain, or if the reduction is great, or the lines of the copy indistinct. With indistinct lines it often facilitates accurate focusing to place a piece of newspaper or other printed matter across the face of the copy, and focus on that, removing it afterwards, of course. After the focus is obtained, fasten the camera in position by means of the set screws at the back, take out the ground glass, remove the large stop and substitute a small one. In photographing line work it is necessary to use a small stop to obtain clear lines, especially if the lines on the copy are fine, or the reduction great. Having the copy focused, the next operation is the

COLLODIONIZING AND SENSITIZING.

Having cleaned and dusted the plate, dip a small brush (or a small stick, around one end of which a tuft of cotton has been wrapped) into a solution of rubber in benzine (see Chapter VIII), and run a narrow strip of this around the edge of the plate. The solvent will evaporate, leaving the rubber around the edge, which will prevent the film slipping from the plate. Now hold the plate by one

corner in the left hand in a horizontal position, and pour the collodion from the vial in a pool near the upper right-hand corner D, as shown in diagram.



Use sufficient collodion to cover the plate and move the plate so that it will run first up to D, then to C, then to A, and finally to B, from which it is to be drained into the phial. While draining, the plate must be carefully rocked to obtain an even coating. When the collodion has become set, invert the plate, place it on

the dipper and lower steadily into the silver bath. Close the cover to the bath and let the plate remain for several minutes, and it will then be ready for exposure.

EXPOSURE.

Close the darkroom door and have the plate-holder resting on its shelf in an upright position and open to receive the plate. Then draw the dipper holding the plate from the bath. If properly collodionized and sensitized the film should be free from any spots or streaks and should have a creamy appearance, with the silver solution on the surface in an even sheet. If the solution lies over the surface in greasy looking streaks, return the plate to the bath at once, moving it around for a moment in the solution, and let remain for several minutes longer. When the plate is found ready to

expose, let it drain for a minute or two, wipe the back with a rag or tuft of cotton, then place in the holder so that the film side will be toward the copy when placed in the camera, close the back of the holder and place it in the position of the ground glass in the camera.

Having the cap on the lens and the lights properly placed, draw the slide from the holder, then remove the cap from the lens. The time of exposure must be a matter of experience, as it will vary with the character of the lens, the intensity of illumination, the amount of reduction of the copy, etc. Short exposure gives broad lines, with lack of intensity in the negative, and the resulting print will be lacking in detail. Long exposure gives fine lines, detail and density, but tends to fill the fine lines. For blue or weak lines give as short an exposure as practicable, for such lines tend to affect the sensitive film, and if the exposure is lengthened, the lines in the image will fill. Light blue lines cannot be reproduced on the ordinary plate. When the ground of the drawing is yellowish, give ample exposure, as such a color does not readily affect the film.

Shorten the exposure time in proportion as the image is reduced in size. If the copy is brightly illuminated it will require less time than when the light is weak. When the exposure has been considered sufficient, replace the cap on the lens, return the slide to the holder, and take the holder to the darkroom. The plate is now ready for development.

DEVELOPMENT.

This must of course be done by the non-actinic light in the darkroom. To develop the image, hold the plate horizontally in the left hand and flow the developer from a beaker or graduate over the film in one even wave; then holding the solution on the plate, keep moving the plate gently to cause the developer to flow from side to side. The negative image will soon appear, and the time of its appearance will indicate whether the exposure was properly timed. If the proper exposure was given, the image will appear in a few seconds, the white ground taking a dark appearance and the lines retaining the color of the film before the developer was applied. If, however, the image flashes up at once and some or all of the lines become darkened, it indicates over-exposure and the lines will be filled, as the whole surface has been impressed and the silver will be deposited to some extent on those parts which should remain clear.

If, on the other hand, the image is slow in appearing, and the details are brought up with difficulty, the plate has been under-exposed. If one portion of the image appears before another, it indicates uneven lighting of the copy, and when that portion which appears first is sufficiently developed, it should be held to wash under the tap while the developer is allowed to act upon the other portions of the plate. Otherwise the fine lines in that portion might fill by the time the other parts become sufficiently developed. When the whole



HALF-TONE FROM PHOTOGRAPH.

With and without background.

image has attained the proper intensity, and the details are visible, the plate should be immediately washed under the tap to entirely remove the developer and unreduced silver solution. The remaining operations can be performed by daylight.

FIXING.

Now flow the fixing solution over the film until the unaffected portions are entirely dissolved, when the lines should appear as clear glass. Then wash the plate well again, and examine carefully to determine if the film has proper density, if the lines are fine enough, and if all are clear. Some experience will be required to detect these qualities. If any of the lines are filled they will have a hazy appearance, quite readily detected, but if not too badly filled they can be cleared by a subsequent operation explained below. If the plate is satisfactory thus far, it must be intensified to make the ground opaque, for in its present condition the light would pass through the ground so readily as to render the negative useless for obtaining a print upon the metal.

INTENSIFICATION.

The intensification may be done with either the copper and silver or the mercury intensifiers. To intensify with the former, flow over the fixed and washed negative the copper solution, until the film becomes white, then wash well and flow with the silver solution until it is blackened throughout, then wash well again. It will usually be necessary to repeat the process a second time, and sometimes

even three or four times, if the exposure has been short, but twice will as a rule be sufficient if the exposure has been rightly timed. If any portion of the ground should still appear thin, after the other portions have become sufficiently dense, repeat the operation on that part alone, to increase its density.

If, after the entire ground has acquired the proper density, the lines all appear sharp and clear, additional blackness may be given to the film by flowing with the ammonium sulphide solution No. 4. Before using the solution No. 4, flow with the dilute nitric acid solution No. 3, and rinse. This will preserve clearness. Wash thoroughly after blackening with the sulphide solution. If the lines are at all veiled or closed, the sulphide is liable to turn them yellow, and in such a case it should be omitted. Additional density in the intensification may at times be obtained by treating the film with a dilute solution of iodide of potassium, after the copper and before the silver is used. This turns the film a lemon-yellow color. This treatment will, however, sometimes cause a stain if the bath and other chemicals are not in a clean condition. The solution is made by dissolving a few crystals of iodide of potassium in water.

CLEARING.

If, after intensifying with the copper and silver solutions, any of the lines are filled, they must be cleared. To do this, flow over the filled portions the dark red solution of iodine and iodide of potassium,

and rinse. Then carefully follow with the *very* dilute solution of cyanide, applying it until the filled portions are cleared. If the cyanide solution is any too strong it will dissolve the film also and ruin the negative. During the operation the water should be kept running from the tap and immediately applied if the action shows any tendency to proceed too far; and at times it is to advantage to let the water run over the plate, while the cyanide is being applied, to cause the action to proceed slowly. This treatment of the film will cause it to become whitened. To blacken it, the ammonium sulphide solution must be used as directed above.

Instead of using the iodine solution strong and the cyanide solution weak, some operators prefer to dilute the former and use the latter strong, intensifying again after the clearing. Instead of using the solutions separately, they may be mixed by adding cyanide to the iodine solution until the color disappears, and diluting with water. The solution is then applied until the lines are cleared. If the lines are too badly filled it will be impossible to clear them, and the negative will be worthless.

THE MERCURY METHOD.

Have the mercury solution in a tray and allow the fixed negative to remain in it until bleached. Then flow with the acid and sulphide solutions to blacken. For greater density, place in the mercury again until of a grayish color, and repeat with the sulphide solution, washing well between

each operation. The sulphide solution tends to weaken the film, and in washing the negative after its use the water should not be allowed to run on it with much force. Having obtained a negative with clear lines and opaque ground, it may be dried spontaneously or over heat and is then ready for reversing, the operations for which will be described in Chapter VIII.

CHAPTER VI.

NEGATIVE MAKING — HALF-TONE
NEGATIVES.

IN making negatives from line drawings, as described in last issue, there are no gradations to be reproduced, but in obtaining negatives from photographs and wash drawings we have every gradation from solid blacks to pure whites, which must be properly rendered. In order to obtain a negative which will be suitable for reproducing these gradations upon the metal plate, we break up the negative image in such a manner that it will be formed of dots and clear spaces, the size of the dots varying to correspond with the different shades in the copy. This is accomplished by placing in front of the sensitive plate when in the camera a glass plate so ruled as to have alternating parallel opaque lines and clear spaces. The light passing through the clear spaces produces the desired effect upon the sensitive film.

THE SCREEN-PLATE.

The ruled plate which is used for the purpose described above is commonly called the screen-plate. These plates may have lines ruled in only one direction, or in several. The screen commonly used has rulings in two directions, one set of lines

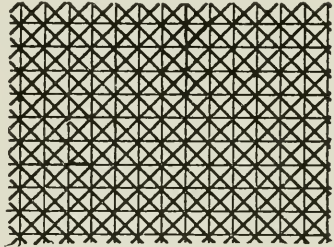
crossing the other at about right angles. Such plates are made by sealing together two "single line" screens, ruled in opposite directions, the effect being to produce a network of the opaque lines. Having such a cross-line screen-plate placed in front of the sensitive plate during exposure, all conditions being arranged to obtain the proper results, the action of the light in passing through the clear spaces is to so act upon the film that when the plate is developed the image will be found to be made up of opaque dots of varying size, those in the whites being largest, the size decreasing as the tints in the original grow darker until they practically disappear in the solid blacks. A print made from such a negative will have separate black dots in the high lights, which will increase in size as the shadows deepen, running into solid lines, the details in the shadows being formed of open dots, which will decrease in size as the shades increase in intensity, until they are absent in the blacks. There is, therefore, a simple gradation corresponding to the shades of the original, each shade being composed of dots of a certain size.

A somewhat different effect than that obtained with the ordinary single or double line screen may be produced by using a screen having the clear spaces of different sizes arranged in groups, and also having the opaque obstructions differing in sizes, and arranged in groups. The result with such a screen is to obtain a printing surface made up of groups of dots and lines, in which the individual members differ from each other, but the



EFFECT OF "FOUR-LINE" SCREEN.

geometrical arrangement being similar throughout the series. Mr. Levy has produced such a screen with four sets of rulings, each set consisting of parallel lines. Two of the sets are crossed at right angles to each other, and the other two also at right angles to each other, and crossing the first two at an angle of forty-five degrees. The apertures are, therefore, in the form of right-angled triangles, but the intersections are so placed that the apertures shall vary in size, and there are also formed two different-sized obstructions to the light, one size by the intersection of two lines, and the other by the intersection of the four.



MR. LEVY'S "FOUR-LINE" SCREEN.

In the print obtained from the resulting negative made through such a screen, the high lights will be formed of single dots corresponding to the four-line intersections, and in the darker shades a smaller dot, corresponding to the two-line intersection, will appear, thus forming two series of dots which will run through the middle tints, increasing in size as the shadows increase in intensity, until they form continuous lines. The details in the shadows will also consist of a series of open dots or spaces corresponding to the clear apertures of the screen, and as the shades deepen the dots representing the clear apertures will disappear in series,

first those corresponding to the smallest apertures, then those corresponding to the next size, and so on until there will be but one series of open dots (those corresponding to the largest aperture) in the shades next in intensity to the solid blacks. With such a screen the detail is more truly rendered, as there is obtained more than one gradation of dots for each shade in the half-tones.

THE NEGATIVE.

A half-tone negative properly made from a subject of good quality should have the dots so closed in the whites that the clear spaces between them shall be separated from each other, the dots decreasing in size as the tints in the original darken, until they disappear in the solid blacks. The clear spaces in the high lights should of course be of such a size that the dots in the resulting print shall be large enough to stand a sufficiently deep etch. There are several factors which have an influence in determining the quality of the negative, as follows :

CHARACTER OF THE COPY.

The character of the copy determines to a great degree the results obtainable. Many photographs are entirely lacking in contrasts, while others are as deficient in detail. The former will, of course, require a treatment to obtain brilliancy in the half-tone, while the latter will require manipulation to obtain detail in the masses of shadow. The surface upon which the drawing or photograph is made will also sometimes cause difficulty in obtaining desirable

effects. As a rule, smooth surfaces are to be preferred to work from, as the grain in rough surfaces will often show to disadvantage in the reproduction. The color or tone of the copy is another element to be considered. The chocolate-brown tones, such as were once obtained in albumen prints, give excellent effects, while lilac and bluish tones tend to give flat results.

ILLUMINATION OF THE COPY.

The illumination of the copy should be uniform, and the lamps should burn without flickering or variation in intensity. The lights should be placed so that reflections on the copy will be avoided. Large copies are more satisfactorily lighted from the skylight than with electric lamps. With a bright illumination a shorter exposure is required than with one of less brilliancy.

SEPARATION OF SCREEN AND PLATE.

If the screen-plate could be placed during exposure so that the ruled lines would be in contact with the sensitive plate, it is plain that the result would be merely a reproduction of the lines of the screen, there being no variation in the size of the dots. In order to obtain the required variation, it is necessary to separate the screen and plate that there may be a certain amount of diffraction of light between them. The effect of such separation upon the relative size of the dots will vary with the distance between the plates. The nearer they are together, the less will be the variation, and consequently the flatter will be the resulting negative.

Therefore, to a certain extent, by varying the amount of separation, we may obtain detail or contrast in the resulting negative. When using coarse screens, it will be found necessary to use a wider separation than with a fine screen, to obtain similar results, all other conditions being the same. When the same screen is used for various subjects, after a suitable separation has been found to give proper rendering of good copies, it will not usually be necessary to change the distance between screen and plate to obtain detail or contrast, as these effects can be secured by altering the area of the diaphragm, as will be explained. If a certain screen and plate are separated to aid in obtaining contrast, the exposure time should be somewhat less than that given when the screen and plate are nearer to each other. To increase the separation in the kit between screen and plate, small pieces of cardboard are placed between the screen and the corner pieces.

AREA OF DIAPHRAGM APERTURE.

Whether the half-tone negative shall have detail or contrast depends to a great extent upon the area of the aperture in the diaphragm used during exposure. If the exposure is made with a small aperture the resulting negative will, upon examination, be found to have the dots in the high lights separated from each other, and the dots in the shadows will be strong and approaching in size to those in the high lights. The negative will therefore be made up of a network of clear lines, and a



HALF-TONE FROM PHOTOGRAPH.

With ornamented background.

print made from it would be formed of a similar network of solid lines. The resulting etching would, therefore, give proofs gray and devoid of contrasts. If, on the contrary, a large aperture is used, the high lights in the negative will be formed of large dots, which will unite to form a network of dark lines dotted with clear spaces, separated from each other, while the dots will rapidly decrease in size as the depths in the shadows increase in intensity, the blacks remaining as clear glass. A print made from such a negative would have the high lights made up of separate dots, the middle tints would be formed of dark lines varying in thickness, and the deep shadows would consist of solid masses. An etching made from such a print would give a "black and white" proof, and if the area of aperture has been too large, detail will be lost in many places where it should appear, the gradations being buried in solid portions of black, while the whites will appear "chalky," and if the clear spaces in the negative have been too small, the resulting dots in the print will not be of sufficient size to stand a deep bite, rendering the plate liable to smudge in the printing.

There is evidently a mean between the two extremes, it being possible to find a diaphragm having an aperture with which a negative can be made the print from which will have the dots in the whites of sufficient size to allow a sufficiently deep etch, and yet so separated that these high lights will appear of the requisite clearness, the dots and lines in the other portions being of such

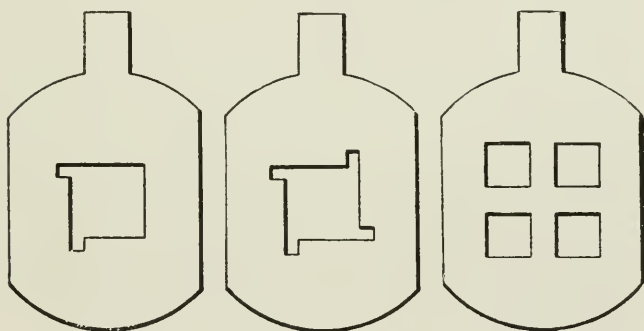
dimensions that in the resulting print we will have a proper correspondence to the gradations in the original. Not only may a single diaphragm be used to accomplish the desired result, but during exposure the area of the diaphragm may be changed, using a small aperture during a part of the exposure and a larger one for the balance, the small stop producing the detail and the large one the union of the dots in the whites.

It has been assumed in the above discussion that the subject possesses the qualities of technical excellence. If, however, a negative is to be made from a copy which does not fulfill such conditions, the size of the diaphragm aperture must be so selected as to produce either detail or contrasts, as the case may require. When the copy is one which has abnormal contrast, a comparatively small stop will cause dots to be formed in the shadows of the half-tone and thus give detail, which will often be an improvement. When, on the other hand, the copy does not have sufficient brilliancy, the use of a larger stop will bring out the contrasts. The degree of detail or contrast to be thus produced to obtain the best effects is, of course, a matter of judgment on the part of the operator. The larger the stop used the shorter should be the time of exposure.

SHAPE OF THE DIAPHRAGM APERTURE.

While diaphragms having round apertures, as usually supplied with lenses, have been generally used by operators, those having other shapes may

be used, the form of the dot being determined by the form of the aperture. Mr. Levy, of Philadelphia, has investigated the effect of various forms of the aperture upon the shape of the dot in the negative, and states as a principle that each transparent space in the screen acts during exposure as a pin-hole lens, and causes an image of the shape of the aperture to be formed upon the sensitive film. From this it appears that if we use a round aperture, the dots in the negative will be round, a square aperture will produce square dots, a triangular aperture triangular dots, etc. It has been found that the dot formed by the use of a square diaphragm will be stronger than the round dot, and will require a shorter exposure time to produce, as it is plain that square dots will close up in



LEVY DIAPHRAGMS.

the whites in less time than round ones. Mr. Levy has invented several forms of diaphragms, three of which are shown here, the first form having a

square aperture with two corners extended, the second having the four corners extended, and the third having a multiple aperture of four square openings, the center being closed. These diaphragms may be made separate from each other, but by an ingenious mechanical arrangement may be combined, and the size and form of the opening may be altered at will to be square or to have either of the two forms illustrated above, a scale on the lens tube indicating the size of the aperture in terms of the focal length of the lens, and also the length of the projecting corners, or the extent to which the center is inclosed if the second form is used. The diaphragms having the apertures thus formed are recommended for use in making negatives from flat originals, as the light in passing through such apertures acts more intensely upon the high lights than upon the shadows, thus producing more brilliant effects than can be obtained with the ordinary forms of aperture. For subjects having the proper contrasts to produce a brilliant negative the square aperture alone may be used during the exposure, but for flat originals the inventor recommends the consecutive use of the square aperture, then the one with four corners extended, and finally the one with the multiple apertures.

EXPOSURE TIME.

The exposure time in making half-tone negatives must be determined by the conditions as enumerated above. If all the conditions are properly

adjusted and the exposure time is insufficient the dots will not be sufficiently closed, and if the time given is too long the clear spaces will either be filled or so small that the dots in the print would not be large enough to stand a deep bite.

MANIPULATIONS.

First see that the screen is clean. A soft, clean cotton cloth will be found useful in polishing it, and any spots and streaks must be removed from its surface, or they will be reproduced in the negative. Breathing upon the surface while rubbing will aid in removing any streaks. When clean, place it in the kit and close the springs upon it; then place the kit in the plateholder so that the screen will be between the lens and sensitive plate during exposure. The operations of developing, fixing and intensifying are similar to those described for line negatives. To expose, the plate after being sensitized is placed in the kit behind the screen, the plateholder being then placed in the camera. During exposure one size of diaphragm may be used, or the size may be varied to suit the conditions. Upon this point the judgment and experience of the operator must be used. After exposure the plate is developed until the details appear, and then fixed. After fixing it should be examined to determine if the proper qualities have been obtained. If the dots are widely separated in the high lights, and the shadows are filled with strong dots, the resulting print will be gray and flat. If the dots in the high lights are closed up, and the

details in the shadows are lacking, the print would be too brilliant, and would in many cases have dots too small to allow the etching to be carried to a sufficient depth. In either case the exposure should be repeated, and the size of aperture and exposure time increased or diminished as required to obtain the proper gradation. The beginner should use but one size of diaphragm during any one exposure until he becomes familiar with the effects produced by the different sizes of the apertures.

The intensification of the negative increases the size of the dots, so that a properly exposed negative need not usually have the stipple in the whites quite closed before intensifying, as that operation will close them up unless too much separated, and leave a strong open space. In some cases, however, a slight union of the dots will not cause the clear spaces to be too small after intensifying. A little experience will enable the size of the dots to be properly judged. A small magnifying glass is of service in examining the negative.

Having obtained a negative in which the gradation appears to be correct, it must be intensified, the process being the same as described for line negatives. If the copper and silver process is used the ammonium sulphide need not be applied, as the two solutions alone will be sufficient for a properly exposed negative. One "dip" may close the stipple sufficiently, or it may require two, and at times three. Washing should, of course, be thorough after each operation. For properly made half-tone

negatives no such clearing process as described for line negatives is necessary. After intensification, the negative is dried and prepared for printing from. An intelligent application of the principles stated in the preceding paragraphs will enable the operator to produce negatives of good quality.

CHAPTER VII.

NEGATIVE MAKING — CAUSES OF DEFECTS IN COLLODION NEGATIVES—
CARE OF SILVER BATH.

THERE are various defects which are liable to occur in the making of collodion negatives, which may be due to faults in the chemicals, or lack of care in manipulation. The following are the most common :

Fog, by which is meant a filling up, or deposit, in those portions of the image which should remain clear. It may be caused by :

Actinic light entering camera, plateholder or darkroom, and striking the sensitive plate.

Insufficient acid in developer or in bath.

An unripened collodion.

Over-exposure.

Over-development.

Developer too strong or too warm.

Fumes of chemicals.

Transparent spots in the film may be caused by :

Dust in the collodion, in the bath, or on the plate.

Excess of iodides in the bath.

- Undissolved salts in the collodion.
- Streaks in the film may be due to :
 - Improper flowing of the collodion.
 - Scum on surface of bath.
 - Bubbles or specks of dust floating in collodion.
 - Removing plate from bath too soon.
- Alcohol in the bath, in which case the streaks will be rather broad and wavy, and run in the direction of the dip.
 - Developer containing insufficient alcohol.
 - Developer striking film with too much force.
 - Developer too strong.
 - Collodion too thick, or over-iodized.
 - Dirty plates.
 - Dirty plateholder, which will sometimes cause blotches like "oyster shells."
- Thin images may be caused by :
 - A weak or insufficiently iodized bath.
 - Under-exposure.
 - Poor lighting of copy.
- Blurred images may be caused by :
 - Improper focusing.
 - Camera being jarred during exposure.
- Uneven density of film may be caused by :
 - Uneven lighting of copy.
 - Uneven coating of collodion.

CARE OF THE SILVER BATH.

To obtain uniformly good negatives requires that the silver bath be kept in proper condition. Every well-regulated establishment has several

baths, so that when one needs rectifying another can be used without causing delay. The following rules will, if followed, keep the bath in proper order :

1. Keep it covered.
2. Isolate it from other chemicals.
3. Keep the hands clean while dipping plates or handling the bath.
4. Skim the top every morning with a strip of clean paper.
5. Filter often through absorbent cotton.
6. Keep the strength up. It does not waste silver to do so. Some clean saturated solution can be added to the bath occasionally when it is in use.
7. When the bath becomes charged with alcohol boil it down. By putting some water in the vessel in which it is boiled, and pouring the bath into it, some of the iodide will be precipitated, and aid in keeping the bath from becoming over-iodized. Then place over heat and let it steam until the odor of alcohol is entirely gone. It is generally best to let it boil down to a small volume. Then test with the hydrometer, and if necessary add clean water to make it register 50. Then filter well, and it is ready for use again. If it fails to work clear, add a few drops of nitric acid C. P.
8. To remove organic impurities add to the bath enough permanganate of potassium solution to turn pink, and place in a clean bottle in the sun for several hours, and filter.
9. Matter in suspension can usually be removed



HALF-TONE—95-LINE SCREEN.

by neutralizing the bath with bicarbonate of soda, and sunning. Filter and acidify again.'

10. If the bath becomes over-iodized, pour it into some clean water to precipitate the iodide, filter, and boil down to required strength. If the bath is evaporated at proper intervals, and the iodide removed as directed in paragraph 7, it will not become over-iodized.

CHAPTER VIII.

REVERSING NEGATIVES.

In order that the proof from the etching may appear unreversed as regards right and left, it is necessary to reverse the negative before obtaining the print from it. There are four methods by which this may be done, as follows :

1. The sensitive plate may be so placed in the holder that the glass side will be turned toward the copy, allowance being made in focusing for the thickness of the glass. The springs of the plate-holder must be specially arranged to hold the plate when this method is used.

2. The image may be taken from the reflection of the copy in a mirror, or what amounts to the same thing.

3. By having a glass prism with silvered hypotenuse arranged to fasten to the front of the lens, the rays of light being reflected from it through the lens and onto the sensitive plate. A modification of this arrangement has the prism as a fixed part of the lens.

4. By stripping the film from the glass support and placing in a reversed position. The two methods last mentioned are those usually employed.

The construction of the prism suggests its method of use.

For turning the collodion film it must be coated with the following solutions :

RUBBER SOLUTION.

Rubber cement.

Benzine, naphtha, or benzole.

Add sufficient of the solvent to the cement to make a thin solution.

PLAIN COLLODION.

Alcohol.	6 ounces
Ether.....	6 ounces
Gun cotton	120 grains
Castor oil	1½ to 2 drams

When the film of the negative is dry and cold, flow over it the rubber solution, and place in the negative rack until dry. When the rubber is dry, flow the collodion over the film, and also let dry. The collodion may be set fire to while it is wet and burned off, if desired, but this sometimes causes a blistering of the film. After the collodion is dry, cut the film to the desired size around the image. If the cut is to be rectangular, the negative should be placed on a board or table with a straight edge, and a T-square and triangle be used in cutting the lines. If the board has two edges at right angles to each other, the T-square alone will answer the purpose. After the film is cut let the negative rest in a tray of water until the film is loosened, then lift one corner with a knife until it may be taken between the thumb and finger

of one hand, raise from the glass, take hold of the adjacent corner also, and strip from glass and lay the film in reverse upon a second sheet of clean glass wet with water. Then lay upon the film a sheet of wet paper, and rub the squeegee over it in various directions to remove all of the water. After this is done, hold face down over the gas stove until the paper begins to dry, then remove it and heat the film, to thoroughly dry it, and place in rack to cool.

If the film refuses to strip from the glass after soaking in the water, or if an albumen substratum has been used under the original collodion film, place the plate to soak in a solution of acetic acid. Curling of the film after transfer is sometimes caused by insufficient oil in the collodion. Should the film fail to adhere to the glass after stripping, flow under it a thin gum-arabic solution, squeegee and dry as usual. Flowing the collodion or rubber over the plate while warm will cause bubbling. The collodion will at times bubble also on a cold plate. This may be remedied usually by flowing some ether over it when it has just set. It is customary in engraving establishments to turn several negatives upon one sheet of glass and print all together on the same sheet of metal. Negatives made with the prism will require varnishing before being used to print from.

CHAPTER IX.

ETCHING — LINE WORK.

CERTAIN organic solutions or mixtures containing a bichromate will, when reduced to a dry state, be so affected by actinic light as to become insoluble. Upon this principle depends the operations for making etched plates as described hereafter. If a metal plate is coated with such a solution, the solution being allowed to dry in a film upon the plate, and then exposed to light under a negative, the light will pass through the clear portions of the negative and render the coating under those portions insoluble, the other portions of the coating remaining soluble, as they are protected by the opaque parts of the negative. These soluble parts can then be removed, leaving the metal bare between the lines of the image formed by the parts of the coating affected by light. The image being, by certain operations, rendered impermeable, a solution can be applied to the plate which will etch the metal away around these lines, and thus leave the image in relief.

PREPARATION OF THE METAL.

The metals commonly used for the purpose of making these plates are copper and zinc, the latter

being used universally for commercial work in line etching, while the former is used principally in making half-tone plates. The metal may be polished by machine or by hand, the latter method being used in most establishments of moderate size. To polish the metal by hand a board should be fitted in an inclined position in the sink so that water from the tap can run upon it when desired, a couple of nails being driven at the lower portion to hold the metal in position when lying upon the board.

If the metal is obtained polished from the dealers, it will be necessary to use the charcoal only to prepare the surface for coating. If it is unpolished it should first be rubbed with pumice stone or Scotch hone until the roughness is removed, and then finished with the charcoal. If the pumice stone is used, its polishing surface should first be ground flat and smooth, otherwise it will scratch the metal. While being polished the metal should be kept wet from the tap, being rubbed in one direction only with the pumice stone or hone and in the transverse direction with the charcoal, the end of the charcoal being used. If any flaws are detected in the surface of the metal they must be removed by punching from the back as described below. Place a pair of calipers so that one point shall be directly over the flaw, the other being directly under it. Press the latter against the back of the plate so as to leave a scratch, the end of which will indicate the location of the flaw. Then turn the plate face down upon a polished iron slab, place the end of a punch over the flaw as indicated



VIGNETTED HALF-TONE FROM WASH DRAWING.

Drawn by J. C. Leyendecker.

By courtesy E. A. Weeks & Co., Chicago.

and strike the other end of the punch with the hammer, which will bring the flaw up to the surface. Then polish again until the surface of the plate is free from scratches and pits. The condition of the finished surface will depend largely upon the charcoal. Some charcoal is gritty and leaves scratches which, if deep enough, would show in the etching. Such grittiness can often be removed by soaking the charcoal in water or the jar of dilute acid.

LINE ETCHING.

SENSITIZING SOLUTION.

Albumen from fresh egg	1 ounce
Water	8 ounces
Bichromate of ammonium.....	15 to 20 grains.

Dissolve the bichromate in the water, add to the albumen and beat up well with the egg-beater in a bowl or mortar. Filter until clean. Some etchers add a few drops of ammonia to the solution.

COATING THE PLATE.

Having polished the plate, file the roughness from the edges, wash it, let some water remain on the surface, and carry it to the room used for coating and drain the water off. Then pour some of the sensitizing solution to cover the plate and drain it off at one corner, repeating two or three times, draining at different corners to equalize the coating. Specks of dirt or bubbles should be removed.

Then hold the plate over the gas stove and warm until dry, keeping it slightly inclined to allow

any surplus fluid to drain. A little practice will enable an even coating to be obtained. When the plate is dry, allow it to cool in the dark and it is then ready for printing.

PRINTING.

See that the heavy glass which is used for the bed plate in the printing frame is clean, and also the back of the negative. Any grit between the two will sometimes cause them to crack when the pressure is brought to bear. Also see that there is no grit in the rabbet of the frame. Then place the negative, film side up, upon the bed plate, and carefully place the coated plate face down upon it. Place the back of the frame upon the metal (usually with a pad of felt or some folded papers between), lay the bars across and fasten at the ends, and turn the screws until sufficient pressure is obtained to make contact between the plate and negative. Then place the plate in the light to print. If in sunlight, support the frame so that the rays will strike directly upon the face. If the electric light is used, give half of the exposure while the frame rests upon its side, then turn it to rest upon the opposite side, and give the balance of the exposure. If the negative is a large one, keep the light swinging, to equally illuminate the whole surface. Do not allow the printing frame glass to become too hot, or it will crack. The exposure time will vary from one to three minutes in the sunlight and from three to ten minutes in the electric light. It will require but little experience to judge of it properly.

ROLLING UP AND DEVELOPING.

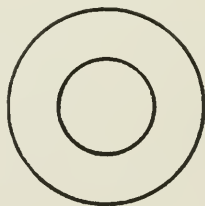
After the plate has been sufficiently printed it must be rolled up with transfer ink to obtain the image. Upon the slab provided for the purpose, place a little of the ink, and with a knife spread it in a line across one end; then with the composition roller distribute it in an even coating over the slab. (Lifting the roller from the slab while rolling will aid in obtaining an even coating.) If any particles of hardened ink or other matter cling to the roller, remove them with turpentine and a rag. When the roller has an even coating of the ink on it, roll it over the face of the zinc until it also is evenly coated. The ink on the zinc should not be too thick; the metal should appear faintly through it. If the ink should be too thick on the metal, clean the roller with turpentine, and when dry roll it over the zinc and it will remove a good deal of the ink. The ink coating should be heavy enough, of course, to absorb enough dragon's blood and form sufficient resist to the acid when burned in.

In cold weather the ink will sometimes refuse to distribute properly under the roller. In such a case wet it with a few drops of turpentine, or warm the slab, and this difficulty will be removed. The roller should be kept free from dirt, and in starting work for the day the slab and roller should be cleaned with turpentine and fresh ink used. A little experience will enable the worker to judge when the plate is properly rolled up. When the proper coating of ink is obtained upon the metal,

place the plate in a tray of clean water (or hold it under the tap) and rub the surface carefully with a tuft of wet absorbent cotton. The parts of the coating which were not affected by the light will rub away, leaving the image in black lines. If the exposure has been properly timed, the lines will all remain unbroken upon a clean ground of metal. If the plate was under-exposed, many of the lines will rub away, and if over-exposed the ink will cling to parts from which it should separate. In such a case a few drops of ammonia added to the water in the tray will often enable it to be removed. Rub the image with the cotton until all of the lines are clean and sharp, being careful to see that the spaces are free from any adhering ink. Then dry the plate by draining and warming over the gas stove. By patting it before warming with a piece of damp chamois skin, rolled into a pad, the surplus water is readily removed.



READY FOR ETCHING.



AFTER ROUTING.

With a camel's-hair brush paint in with the transfer ink, wet with turpentine, any parts of the

lines which may be broken, and also the largest open spaces as shown in the cut, one being the appearance of the plate when thus painted in, and the other the appearance after routing and finishing.

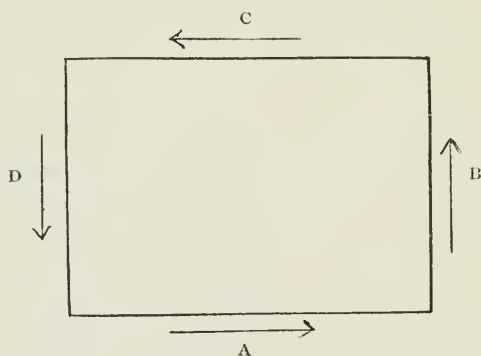
The painting in of these spaces supports the roller and prevents smudging in the subsequent rolling.

POWDERING AND ETCHING.

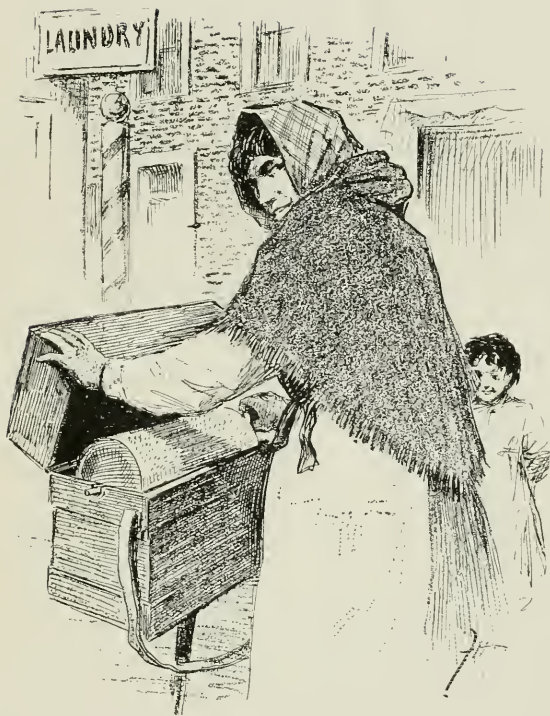
After the plate has been thus painted, it is ready for powdering. Have some dragon's blood in the powder box, and dump it upon the surface of the plate, and then brush off the surplus with a broad soft brush, finishing with a tuft of dry cotton until the metal spaces are clean. The dragon's blood will adhere to the ink. The plate is now held over the gas stove and heated until the powder incorporates with the ink, as shown by its turning a rather glossy black. There are two grades of dragon's blood, one a dark red color, the other lighter in color. The latter will burn in more readily than the other, and form a strong resist. After the plate is thus heated paint the back with asphalt varnish, cool, and the image being now able to resist the acid, the plate is ready for the first bite.

The acid used for this bite should not be very strong. The proportions are not arbitrary. The beginner, however, may take about two and one-half parts of the commercial nitric acid to thirty-two parts of water, for the first etch. Place this in the etching tub and immerse the plate in it.

Then rock the tub, and as the action of the acid proceeds, keep the plate clean by brushing with the bristle brush used for the purpose. This bite need not be deep. Three to five minutes will be sufficient, when the metal will be found so etched away as to leave a line in slight relief. Then remove the plate from the acid, rinse, dry off the surplus water with a towel or the damp chamois, and warm over the stove. Before continuing the etching the sides of the lines must be protected to prevent the acid attacking them and causing breaks. This is usually done by "powdering four ways," as follows: Take the plate to the powder box, and dump some of the dragon's blood on it, then beginning at one edge of the plate pass the brush over it from that side to the side opposite, so that the powder will be brushed against the sides of the lines.



For instance, in above diagram, if the brush is started at the side D, brush in direction indicated by the arrow A toward side B. Hold the brush



ZINC ETCHING—CRAYON EFFECT.

From sketch by Frank Holme.

upright, and brush in even sweeps without lifting from one extreme edge to the other. When the spaces between the lines are clean, and the lines all "covered," heat the plate again to cause the powder to adhere to the lines, and, when cool, powder in a similar manner in the direction of arrow B, moving the brush from A to C, and heat again. Repeat the powdering in the remaining two directions, heating after each, and if properly done the powder will adhere so as to protect the lines on all sides.

When cool, the plate is ready for the second bite. The etching is proceeded with the same as at first, the time being increased somewhat, and when it has been carried far enough the plate is again rinsed, dried and powdered as before, and placed in the bath to etch again, the strength of bath and time being increased. When the action has again proceeded sufficiently, it is removed from the acid and prepared for the fourth bite. This may be done by simply powdering again as for the other bites, but it is customary with many etchers to roll the plate up again to form a thick coating of ink over the tops of the lines before powdering for the fourth bite, so that the ink will run down the sides of the lines during the heating and form a more impermeable coating. This rolling up is best done with the leather-covered roller. After this rolling up the plate is powdered again and given the fourth bite. The four bites will, as a rule, be all that are necessary for the ordinary work, and the plate can be cleaned, routed and mounted.

A "clean bite" may, however, be given to remove the "shoulder" from the lines. During the operation of powdering and etching, the lines are not always etched straight down, but are formed in steps which, if prominent, will print up and make a broad line in the resulting proof. To remove this "shoulder" to a certain extent the ink and powder are first removed from the plate after heating and flowing with lye or alcohol, using a stiff scrubbing brush. A coating of ink is then rolled over the top of the lines and powdered and heated so that while the top will be protected the sides will remain bare. The plate is then placed in a weak solution of acid and etched for a few moments, the effect being to etch away some of the shoulder and give a sharper line. This must be done with great care. After cleaning, the plate is ready for the finisher.

The strength of acid and time of etching for each bite cannot be stated arbitrarily. They depend largely upon the character of the etching, some lines not being able to stand the action as long as others, and it requires some experience to judge when the biting has proceeded far enough, the object being to allow the acid to act as far as possible without undercutting or breaking the lines. The experienced etcher does not, as a rule, measure his acid, and judges by appearance of the lines when the operation must cease. The beginner, however, may commence by using the following proportions for the solution and times for biting:

First bite— $2\frac{1}{2}$ parts acid to 32 parts water.

Etch two to three minutes.

Second bite— $2\frac{1}{2}$ parts acid to 32 parts water.

Etch five to six minutes.

Third bite— $3\frac{1}{2}$ parts acid to 32 parts water.

Etch eight to ten minutes.

Fourth bite—5 to 8 parts acid to 32 parts water.

Etch ten to twelve minutes.

The beginner should start with subjects having strong lines, and should carefully watch the action until he has acquired such experience that he can etch without timing the bites. For regular work four bites is usually sufficient, but some plates may be given five and others will require only three, the latter being the case when the lines are close together. In many establishments the clean bite is omitted, care being taken to powder the plate clean so that no excess of powder will cling to the lines and form a large shoulder. For a clean, deep job the plate may have the spaces routed before the last bite.

In powdering the plate, the brushing need not be confined to only the four directions. Some etchers apply it in various ways until the lines are sufficiently protected. No powder should be allowed to remain on the open spaces, and to prevent excessive shoulder no more than enough to protect the lines should be left adhering to them. However, where an extra strong bite is to be given it is sometimes well to powder twice around the plate. After the second or third bite the small spaces will

fill with the powder, but the lines being close together, great depth is not required as in the wider spaces. Should any of the powder adhere to the open spaces, causing roughness, a knife or scraper can be used to clean them. After the finishing etch has been given, the coating should be removed from the plate by scrubbing with lye, and the plate delivered to the router. Alcohol will also remove the coating, but is more expensive than lye.



VIGNETTED HALF-TONE—133-LINE SCREEN.

From wash drawing by J. C. Leyendecker.

By courtesy Northern Trust Company, Chicago.

CHAPTER X.

ETCHING — HALF-TONE WORK.

THE ENAMEL PROCESS.

SENSITIZING SOLUTION.

A.— Albumen from fresh eggs	5 ounces	2 $\frac{1}{2}$
Water.....	2 ounces	1
B.— Bichromate ammonia.....	140 grains	40 gr
Water.....	2 ounces	3 drops
Ammonia	a few drops	2 $\frac{1}{2}$
C.— Le Page's liquid glue	5 ounces	1 $\frac{1}{2}$ - 2
Water.....	3 to 4 ounces.	

Beat up the eggs with the water, then add the solutions B and C, and mix all together thoroughly. The solution must then be filtered several times through sponge or absorbent cotton until free from specks and bubbles. Make also a solution of eosine (red shade) by dissolving some of the powder in hot water and keep in a tray for use.

MANIPULATIONS.

Have the copper polished and the surface holding a film of water, take it to the darkroom, drain off the water and flow the plate with some of the enamel solution, draining the surplus off at one corner, then flow once or twice again and drain, removing any specks or bubbles with a small brush or stick. Having the solution clean on the plate, put it in the whirler face down, having one

corner in the opening in one of the clamps and the opposite corner in the opening of the other, the clamps being so placed that the plate will be centered. Then turn the hand wheel of the drill so that the plate will be given a rapid whirling motion which will spread the solution evenly over the surface. The gas stove under the whirler should be burning so as to warm the plate and dry the coating. The plate need not be heated excessively. Enough to dry it will be sufficient. If it is not convenient to have a stove under the whirler, the plate may be whirled cold until the solution is partially dried, and then removed from the whirler and heated to dry.

If the coating upon examination now appears clean upon the plate, let the plate remain in the dark until cold, and then expose under a half-tone negative as directed for exposing line plates. When it is considered as sufficiently printed, remove it from the frame, place in the solution of eosine for a moment, then wash under the tap. The image will appear of a brilliant red color, and should be washed until the details are all clear. The eosine solution is simply to color the image to render it clearly visible during development. Some etchers omit it, but its use enables the development of the details to be more readily watched. If the plate has been properly exposed the dots and lines of the image will correspond with the clear spaces in the negative, and if the negative is one of good quality, the details will be open and the high lights will be clear with dots strong enough to allow the

proper depth of etch. These dots should be square and may be separate from each other, or just touching at the corners, but the union should not be so strong as to prevent the separation of the dots in etching, for the best effects are obtained when the high lights are composed of separate stipple. If formed of lines the proofs will be too dark. If the print has been over-exposed, the details will be filled and the dots in the whites will probably run into heavy lines. If under-exposed, the dots in the whites will be too small to stand the etching, and some will perhaps be washed away in developing, while the image will be weak. When a properly exposed print has been obtained and developed it should be flowed several times, after being taken from the tap, with grain or wood alcohol to remove the water, and then dried spontaneously, or the alcohol may be ignited and burned off.

The print must then be burned in, which is done by holding the plate by means of a pair of pincers over a strong, steady heat, until the coating becomes of a chocolate brown or black color. Then let cool and rub with a dilute solution of chromic acid, which will clean the copper and enable any spots to be readily detected. The plate must now be spotted, that is, any stipple which is missing must be replaced by some substance which resists the etching fluid. Either asphalt or the transfer ink may be used for this purpose. A small camel's-hair brush should be obtained, and some of the asphalt being placed upon it, the brush

is drawn to a point and touched to the spots from which the stipple is missing, and also any portions of the image which it is desired shall appear solid black are painted in. If the ink is used, the plate is powdered with dragon's blood, which is brushed off with cotton, the plate then heated enough to burn in the powder adhering to the spots of ink. The back is then painted with asphalt varnish, and the plate cooled. It is then ready to etch.

For the etching fluid prepare a strong solution of perchloride of iron, place it in a tray, immerse the plate in it and brush the face of the plate with the etching brush. The plate can now be allowed to rest in the solution, being brushed occasionally to clean the face from the sediment which results from the chemical action. The tray may, if desired, be rocked, but this is not necessary. Examine the plate at intervals, and when the dots in the high lights appear to have had as much etching as they will stand, brush the plate and wash immediately under the tap. If upon further examination the dots appear large enough to stand more, return the plate to the solution and continue the etching. When finally the action has proceeded far enough, rinse the plate, clean with solution of chromic acid, rinse again, clean the asphalt from the back with turpentine, dry and prove.

ETCHING VIGNETTES.

Very pretty effects can often be obtained by etching a vignette or blended border around the image. The plate is first etched in the ordinary



ZINC ETCHING.

Copyrighted.

From pencil and pen drawing by Fanny.

By courtesy The Ault & Wiborg Co., Cincinnati, Ohio.

manner, and given a bite deep enough for printing. It is then dried and the face painted in solid with the asphalt or transfer ink, the edge of the paint *not* being carried to the edge of the plate, so that a ground of stipple is left around the painted portion. The plate is then returned to the etching solution and etched a few moments to reduce the stipple in size. It is then rinsed and dried and painted again, the paint this time being extended a little further. Another bite is then given to reduce the size of the remaining stipple, and the operations are repeated. When the desired number of tints are obtained, the plate is finally etched until the remaining border of stipple is broken away. The face is then cleaned with turpentine or alcohol as the case may require, and the edge routed and trimmed with the hand tool. The edges of the paint should be wavy and may require a little artistic taste to produce the desired effect. A proof from such a plate will have a border formed of a gradation of tints, blending from dark to light. It requires some practice to obtain an artistic effect, as the edges of the tints must not be too pronounced. Three or four and even as many as five tints may be obtained by skillful etching.

The "Full Tone" or "High Light" process by which plates are produced with certain parts of the ground free from stipple is done by simply painting in the plate, leaving those parts unprotected, then etching until the stipple breaks away. The parts are then deepened, and finished with the tool. In printing, to bring up any portion of the plate

heavy, shade the other portions after they have been exposed sufficiently, and allow the light to act longer upon that part.

In etching, avoid excessive brushing. Use the brush only occasionally to clean the plate, unless it is desired to etch out some part especially light. To obtain a better idea of the actual depth of the etching than can be determined by the appearance of a stipple, scratch off with a knife some of the enamel on the margin of the plate. The scratch will etch down and the depth can be felt with the finger nail. The proportions given for making the enamel solution are not arbitrary. Different amounts of the constituents can be used if desired. An excess of glue will cause a tendency to fill in the print, while a solution which is too thin will peel from the plate in etching.

Half-tone etching may also be done by the albumen process, using the same solution as for line work which is generally used for half-tones on soft zinc which will not stand the heat in burning in the enamel solution.

CHAPTER XI.

FINISHING AND MOUNTING PLATES.

AFTER the etching of the line plate is finished it is tacked to a board and placed in the routing machine, and all the larger open spaces deepened with the routing tool. If several negatives have been printed on one sheet of zinc, each image is cut out, a thin border of zinc being left around it. The cut is then fastened to a block by tacks driven through the routed spaces and around the edge, and the block planed type-high. Any burr remaining on the lines is then removed with a hand tool, and the plate is ready for proving.

In mounting a half-tone cut, a beveled edge may be formed around the cut with the routing or beveling machines, and the plate fastened to the block by tacks driven through this edge. Another method is to mount the plate from the back as follows: Saw the margin of metal from around the image, leaving enough for a black line (if the line is wanted), and bevel the edge with a file, removing the burr from both sides. Clean the back of the plate and scrape the surface bright in several places, leaving several deep scratches in the places thus brightened, then upon each place drop some hydrochloric acid, and lay a thin piece of

solder upon it. Upon the solder set a small screw and direct the flame of a blowpipe upon the solder until it melts and forms around the head of the screw, holding the screw in position by any convenient tool. The solder should not be too large or it will form too large a mass when melted. Having thus soldered screws to the several points, which should be evenly distributed over the plate, set the plate screws down upon the wood block, length of the plate with the grain of the wood, lay another block upon the face of the plate and strike it with the hammer, so that the screw will leave marks upon the face of the first block. Then with a one-fourth inch drill, drill holes through the block at these points, after which insert a countersink drill in the chuck and with it drill from each side of the block into the holes made by the one-fourth drill, letting the countersink go below the surface of the block on each side. Sandpaper the face of the block and place the plate on it so that the screws will sink into the corresponding holes, allowing the plate to rest flat upon the surface of the block. Then protecting the face of the plate with another block clamp it tight, and with a small ladle pour melted type metal into the holes on the opposite side, not allowing it to come to the surface of the block. When it is cool the plate will be firmly fastened to the block.

Saw the block around the metal, leaving a small margin of wood and then it is ready to trim. Place the block on the trimmer, having the gauge set so that the knives will just catch one edge, and pass



HALF-TONE—150-LINE SCREEN.

the table back and forth, giving the gauge screw a slight turn each time until the wood is trimmed up to the metal. If the plate is so placed that the wood will not trim parallel to the edge of the plate, place a piece of folded paper between the block and gauge to cause the part at which the wood is thickest to be moved farther toward the knives. Trim each edge, running the block through slowly when making the last cuts, and then make it type-high in the planer. If the type metal should be found to come to the surface of the block it should be routed down. In mounting line and half-tone cuts together, if the plates are not of the same thickness the thinner ones must be underlaid to bring their surfaces to the level of the thickest plate. Cherry wood is usually used for blocking plates, metal blocks being used for those from which stereotypes are to be made, such as line plates for newspaper work.

The first proofs from half-tone plates will often show black spots. In such a case the plate is given to the engraver who tools them out. The half-tone may often be improved also by having certain parts burnished to make those parts in the proof appear darker. For fine magazine work it has become customary to use the tool very extensively upon half-tone plates, many of them being given the appearance of fine wood engravings. The tool is also often used to vignette portraits and to clear away the stipple in places where it is desired to have clear whites in the proof.

CHAPTER XII.

DRAWINGS—PHOTO-LITHOGRAVURE.

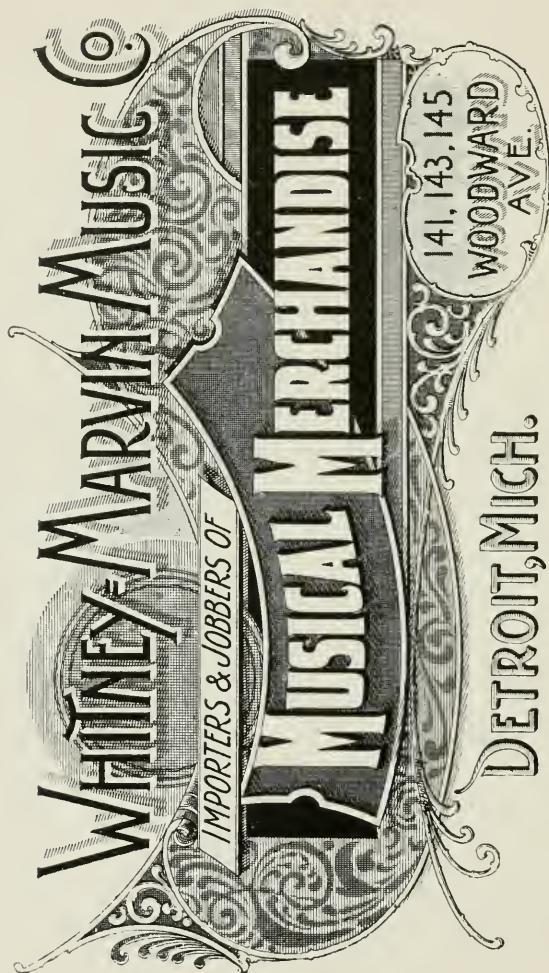
THE line drawings for reproduction should be made with black ink and the lines should all be sharp and bold. Gray and fine lines are extremely difficult to reproduce, especially if the reduction is great. To make drawings rapidly and accurately, a common "wrinkle" is to draw the lines over a silver print, the photographic image being afterwards bleached out, leaving the drawing alone on the paper.

The method is as follows: Obtain some plain salted paper and sensitize it by brushing over the surface a tuft of absorbent cotton wet with a solution of silver nitrate. Dry in the dark and expose under an ordinary negative made from the copy to be reproduced until the image shows a dark red or purple. Wash, then place in a dilute solution of acetic acid for several minutes until the image is fixed. Wash again, then dry and make the drawing over it with Higgins' waterproof ink. When this is dry, flow over the print a saturated solution of mercuric chloride in alcohol, or in about equal parts of alcohol and water. The red image will be removed, leaving the drawing, after which

the paper should be rinsed and dried, being then ready for the photographer.

Another method to obtain the outlines of the drawing is to make a ferrotype, or "tintype," and over this to place a sheet of thin transparent gelatine or celluloid, the outlines being scratched in with a point. Powdered graphite or other pigment is then dusted over the gelatine and adheres to the lines. By placing the gelatine over a sheet of paper, line side down, and rubbing it, the lines will be transferred to the paper. The ferrotype is made in the same manner as a wet plate, the sheet of metal being substituted for the glass.

In drawings for colorwork it is often desired to have the part of the drawing for each color made separate. The whole drawing is first made in the colors as they are to appear in the original, then tissue paper is placed over it and the outlines for one color drawn upon it. The back of the paper is then covered with some pigment (rubbing a blue pencil over it is the easiest way), laid back down on another piece of paper or card, and the lines traced over, thus transferring them. That portion of the drawing is then finished up as desired and the others obtained in a similar manner. "Scratch board" is generally used for making drawings upon, as it has a smooth surface with no grain to appear in the reproduction, and alterations can be made upon it without altering the character of the surface.



A PHOTO-LITHOGRAPHURE PLATE.

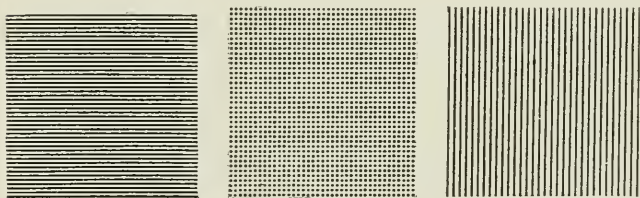
PHOTO-LITHOGRAVURE.

By the term photo-lithogravure, as used here, is meant the reproduction of line drawings containing tints of lines or dots.

The method largely used for placing these tints upon the copy is known as the Ben Day process.

The apparatus consists of a film of gelatine mounted in a frame, the form of the tints being so placed in relief upon it that when rolled up with ink they can be readily transferred to the copy by placing the film above it and pressing upon it with a burnisher or other convenient instrument. Similar results, however, may be obtained by the following method.

The necessary apparatus is simply several plates ruled to form tints of lines or dots, some examples of which are shown.



These rulings are made upon plates of stereo-metal mounted on blocks of wood to be type high. We will now consider the application of the method as shown in the example (page 92). First there was drawn the outline of the letters with the curves and scrolls forming the skeleton of the drawing.

The tints were then all put in as follows : Take the dotted tint around the numbers 141, 143, 145, which also appears at the upper portion of the plate near the name Marvin. A sheet of smooth tissue paper was tightly stretched over the face of the drawing, being pasted around three edges. Then the outline of the tint was drawn with a pencil. After this was done a card was slipped under the tissue and the tissue cut out with a sharp knife on the lines just drawn, the card being then removed, leaving the space on the drawing bare where the tint was to be placed. The drawing was then placed on the bed of a hand press, the tint block rolled up with ink and placed face down upon it. The pressure being then brought to bear leaves the dots on the face of the drawing in the open space, the other parts of the drawing being protected by the tissue. This sheet of tissue being then removed another one is put on, the outlines for another tint drawn and cut out, the tint block being rolled up and the impression being taken as before, leaving another tint on the drawing, and so on for the remaining tints.

To get the cross-line tints, two impressions are taken from a single-lined plate, the position of the plate for the second impression being at right angles to the first position. In making a shade line around letters where it is desired to have a white space between the letter and the shading, the tint may be allowed to run up to the letter when the impression is made, the white space being scraped out afterwards. When letters which are to appear white are to be protected while the

impression is being made, tissue cut out to fit the letters are pasted on them at two or three points, the paste being removed afterwards. When the tints are all inserted in the drawings the reproduction is made in the camera as usual. This process gives results similar to those obtained in lithographing, and very handsome effects can be obtained by running the tints in colors.

CHAPTER XIII.

DEVELOPMENT OF GELATINE DRY PLATES.

GENERAL PRINCIPLES.

IN the development of the gelatine dry plates the reduction of silver to form the image is obtained by an agent which decomposes the silver salts affected by light. Combined with this agent several others are usually used, each of which has a special influence in determining the result.

Besides the reducing agent we will have, therefore, the following components in the solution. An alkali, usually sodium carbonate (sal soda). The action of the alkali is to render the film more easily permeable, and to increase the affinity of the reducing agent for oxygen, thus increasing its reductive powers, causing the reduction to take place in the parts least affected by light before great density has been obtained in the high lights. Detail is therefore obtained in the middle tones, producing an image full of gradation, and should the proportion of alkali be too great, the reduction of the silver will be rapid, and take place over the entire surface, causing fog. If there is an excess



ZINC ETCHING.—BLACK AND WHITE EFFECT.

Drawn by John Sloan.

of alkali, yet not sufficient to cause fog, the details will develop too rapidly and be so strong when the proper density in the high lights has been reached, that the negative will be too flat and wanting in contrast.

To prevent the reducing agent from absorbing oxygen from the air, a sulphite, usually sodium sulphite, is added to the developer. Having a greater affinity for oxygen than the reducing agent, it takes up the oxygen, thus preventing the decomposition of the reagent, and also preventing stain.

To prevent the too rapid action of the reagent and to preserve clearness, a restrainer, usually bromide of potassium, is used. The action of the restrainer is more energetic upon the middle tones than upon the high lights, and when by over-exposure, or excess of alkali, these portions tend to develop too rapidly, it is used to retard the action until the high lights have gained in intensity, thus obtaining contrast, where desired, and preventing fog from any excess of alkali.

An excess of the restrainer acts, therefore, like an excess of the reducing agent to produce hardness and contrasts.

It is evident that we may mix the developer in proportions to promote detail or contrasts, or that we may manipulate it so that one constituent will retard the action of another to any desired extent. There are certain proportions, however, of the constituents entering into the composition which may make what we may term a normal developer,

that is, a developer which when applied to a properly exposed plate will bring out the gradations and intensity in proper order, producing a negative of the best technical quality.

As stated in a preceding chapter, the time of exposure is a matter of no less importance than the development of the negative, for while with skillful manipulation good results may be obtained from the plate slightly under or over exposed, it is only with correct exposure that the best effects are produced.

The exposure time of the gelatine plate is much shorter than for the collodion, varying from a small fraction of a second to several seconds (or perhaps under special conditions to an extended time).

A correct exposure properly developed will yield a negative having gradations to render the details in the subject, but will preserve the contrasts sufficiently to avoid flatness in the resulting print.

Over-exposure tends to produce negatives full of detail, yielding prints without brilliancy.

Under-exposure tends to produce negatives with strong contrasts, lacking in detail, the resulting print being hard.

The treatment for over or under exposed plates will be given below.

Various reducing agents may be used in the development of gelatine plates, but pyrogallol is considered the standard by the majority of professional photographers.

PYRO DEVELOPER.

Prepare stock solutions as follows :

- A.—Sodium sulphite, 40 by actino-hydrometer ; and
- B.—Sal soda, 20 by actino-hydrometer.
- C.—Bromide of potassium, 1 part to 9 or 10 parts water.

For convenience these solutions may be made up in quantities.

To prepare the developer, take one part of the sulphite solution A, one part of the alkaline solution B, and two parts of water, then add $2\frac{1}{2}$ grains of pyro for each ounce of the resulting solution. Then add a few drops of the bromide solution C.

In cold weather enough heat may be applied to the water to just remove the chill, but it must not be warm.

In hot weather increase the proportion of water to $2\frac{1}{2}$ or 3 parts, and keep the solution cold by placing ice in it.

FIXING BATH (CRAMER).

A.—Water	1 quart
Sulphite soda.....	4 ounces
Sulphuric acid	$\frac{1}{2}$ ounce
Chrome alum	3 ounces
B.—Water	3 quarts
Hyposulphite soda.....	32 ounces

Dissolve A and B separately and mix. In cold weather use one-half the quantity of A.

DEVELOPMENT.

In the development of the plate, the points to be considered are : First, the time in which the image

appears; second, the contrasts; third, the detail; fourth, the intensity. An intelligent judgment of these will enable the operator to determine whether the exposure has been of the proper duration, and conduct the development accordingly.

Place the plates in a clean tray, which should be kept for this purpose alone, and flow the developer over them in an even wave, using enough to cover the plates. Then rock the tray to cause the developer to flow from side to side. If the exposure has been properly timed the high lights of the image will appear first, then the gradations in the middle tones, those corresponding to the lighter shades first, being followed by the darker shades, then the details in the shadows. When all the gradations have thus appeared in proper order, the development is continued until the proper intensity is reached, which is determined by the appearance of the plate when held up to the red light. Only experience will enable the intensity to be properly judged. Some papers will require a denser negative than others.

If the exposure time has been too short, the image will be late in appearing as compared to the normal, and the details in the half-tones and shadows will hang back, and if the development is carried on as for proper exposures the high lights will gain the desired intensity before the details will come out, thus producing a hard negative devoid of detail. In such a case simply place the plate in a tray containing developer diluted with water. The development will then take place



VIGNETTED HALF-TONE, HIGH-LIGHT EFFECT—100-LINE SCREEN.

From wash drawing by W. L. Wells.

slowly, the details having time to appear before the high lights assume any great intensity.

When the details have properly appeared, the plate can, if necessary, be returned to the normal developer until the proper intensity is obtained.

Some operators place under-timed plates in a developer to which an excess of alkali has been added, but such forcing of detail will seldom yield a good negative, and there is great liability to fog.

If there is any detail which can be brought out the method given above will do it. A badly under-timed plate will, of course, never produce a good negative.

If the plate has been over-exposed, the image rapidly appears, the details coming up with the high lights, and the negative will be flat. In such a case it should be placed in a tray containing normal developer to which there has been added more of the bromide solution. The restrainer will cause the reduction in the portions least affected by the light to be retarded, while the high lights will gain in intensity, thus producing contrasts.

When a number of plates are developed in succession the developer will deteriorate, and should be replaced by fresh as occasion may demand.

During development, the plate should be examined from time to time by holding it between the eye and the red light, and when the proper intensity has been obtained it should be rinsed for a moment under the tap and placed in the fixing bath, in which it should remain for five or ten minutes after the white color has left the film.

After fixing, it should be washed in running water for at least two hours to remove the hypo from the film.

When taken from the water, the ball of the hand may be passed over the face of the negative to remove any sediment from the water, the plate being then placed in the rack to dry.

Instead of using dry pyro, it is customary with many operators to have a pyro solution, various formulæ being given by platemakers. The above formulæ with dry pyro, however, will give results second to none.

A number of other reducing agents are on the market, some of which dispense with the use of an alkali, but for all-around work with all brands of plates pyro continues as a standard.

Among the other agents which have gained in favor metol is one of the best, giving excellent results. This developer may be prepared as follows :

Make stock solutions of sal soda at 30, and sulphite at 60 by the hydrometer.

Take 20 ounces of each and add to it 40 ounces of water in which $\frac{1}{2}$ ounce of metol has been dissolved.

In warm weather dilute with an equal quantity of water.

The manipulation is the same as with pyro.

INTENSIFICATION.

If the development of the negative has not been carried far enough it will be thin and require

intensification. Various formulæ may be used, but those containing mercury are commonly employed.

Dissolve $2\frac{1}{2}$ ounces of iodide of potassium in 12 ounces of water and pour into it gradually a saturated solution of bichloride of mercury. A red precipitate of mercuric iodide will be formed. The mercury solution must be added until this precipitate cannot be dissolved by shaking. Avoid adding any more mercury, however, than will make the solution very slightly turbid. Then add $2\frac{1}{2}$ ounces hyposulphite of soda, and when dissolved add water to make up to 40 ounces.

For use, take one part of the above solution to three parts of water and immerse the negative after fixing and washing until sufficient density is obtained. If the hypo has not been thoroughly washed from the film, the intensifier will cause stains. If over-intensified the density may be reduced by leaving the negative in the fixing bath for a short time.

REDUCTION.

Negatives which are too dense may be reduced by a dilute solution of hypo to which a little of a solution of potassium ferricyanide has been added.

The solutions may be made up of $\frac{1}{2}$ ounce of the salt to 8 ounces of water. Add a little of the potassium solution to the hypo solution and immerse the negative until sufficiently reduced, then remove and wash.

CAUSES OF DEFECTS IN GELATINE NEGATIVES.

Fog.—White light entering darkroom or camera, over-exposure, excess of alkali in developer, hypo or other chemicals in developer, developer too warm.

Negative too thin.—If the shadows lack detail, under-development; if the shadows have detail, weak developer, or exposure too great.

Intensity too great.—Over-development, reagent in excess in developer, or warm developer.

Abnormal contrasts.—Under-exposure or developer too strong.

Frilling.—Solutions too warm, insufficient alum in fixing bath or prolonged washing.

Flatness.—Over-exposure or too much alkali in developer.

Spots.—Dust or bubbles in developer.

Stains.—Developer oxidized, impure chemicals or not enough sulphite in developer, deteriorated fixing solution or insufficient fixing.

Streaks.—Developer allowed to flow unevenly over plate when first applied, or fixing bath acid.

Crystals on negative.—Hypo not all removed from film.



ZINC ETCHING OF PORTRAIT—MEDALLION EFFECT.

From drawing by Jules M. Gaspard.

CHAPTER XIV.

ORTHOCHROMATIC PLATES — COLOR
WORK.

COLOR.

THE undulatory theory of light, which is now accepted as explaining most satisfactorily its various phenomena, assumes that light is produced by vibrations of the ether, an imponderable, colorless, perfectly elastic fluid which is supposed to penetrate all matter and occupy all space. The waves of ether, being generated by the source of light, are transmitted from it in all directions, the vibrations being transverse to the direction in which the ray of light is moving.

The sensation of white light is not caused by one set of vibrations, but by several, for if we pass a ray of white light through a prism it will be decomposed, and the result will be a series of colors (the spectrum) which can be shown upon a screen, each pure color being produced by ethereal waves always of the same length but differing in length from the waves which produce any of the other colors. This decomposition of the white light is caused by the refraction or bending of the rays as they pass through the prism, each of the component rays being bent at a different angle than any

of the others. The waves which are the longest and which produce the red sensation are refracted least, and the shortest waves—those which produce the violet sensation—are refracted most, the waves producing the intermediate colors being refracted more or less according to their relative lengths. Besides the rays of the spectrum which affect the eye, others exist which are not visible and which can be detected by their chemical effect.

Pure colors—that is, colors which are produced by only one set of vibrations—are to be found only as spectral colors. They cannot be obtained from any pigment, for no matter how nearly any pigment may appear optically to approach a color of the spectrum, spectroscopic analysis will show its color to be produced by more than one set of vibrations.

The red, green and blue-violet of the spectrum are the fewest pure colors from which by combination in certain proportions of two or the three any other color may be produced, and they are therefore termed primary colors. The sensation of yellow, for instance, may be obtained by the combined action of the pure red and green rays, purple of red and blue or violet, while white light is produced by the combination in equal quantities of all three primary rays. The proportions may be varied to produce other colors. Lilac may be produced by the combination of blue and red, the blue rays predominating, while orange may be obtained by combining red and green, the red predominating.

The color of any object (or pigment) depends upon its properties of absorption or reflection of the primary rays. If illuminated by white light and all the rays are reflected, it is said to be white. If all the rays are absorbed, it is said to be black, and if some are absorbed and some reflected the color will be determined by the reflected rays; for example, if the green and blue-violet rays are absorbed and the red reflected, the object is said to be red. Some objects, such as colored glass or colored solutions, allow some rays to pass through them, absorbing or reflecting others, and this property is utilized in filtering out certain rays which it is desired shall act upon the sensitive plate to obtain certain results.

Two colors which combined produce white are called complementary colors. Since the three primary colors combined produce white, it follows that the color resulting from the combination of any two of them is complementary to the other primary. Primary red and green give the sensation of yellow, which is therefore complementary to the primary blue.

ORTHOCHROMATIC PLATES.

If a negative is made from a colored object by using an ordinary photographic plate, it will be found that the true color values have not been obtained in the negative—that is, the reds and yellows will appear too dark in comparison with their values in the original, while the blue will

appear as white.* This is due to the fact that the only visible rays of the spectrum which affect the ordinary plate are the blue-violet rays, these being the only rays absorbed (except the invisible rays from beyond the violet, which are known as the ultra-violet rays).

This defect in the plate may be remedied, however, by treating the film with certain dyes which may be added to the emulsion before the plate is coated, or the coated plate may be bathed in a solution of the dye. If a plate thus prepared is exposed to a colored object, a transparent yellow filter of the proper intensity being so placed that the light will pass through it before acting upon the plate, the resulting negative will show practically the true color values, the blacks, reds and blues appearing as dark parts in proportion to their relative intensities, while the yellows will appear as light parts.

The use of the yellow filter is to cut off the action of the blue-violet rays to which the plate, of course, remains sensitive.

Such a negative is called orthochromatic, from the Greek words meaning correct and color.

COLOR PLATES.

Instead of sensitizing and exposing the plate to obtain the effect of all the colors, it may be rendered sensitive to certain rays and others excluded

*The effect of a pure red or yellow would be practically the same as black. That red and yellow pigments will usually have some action on the plate is due to the fact that they reflect more or less blue-violet — no pigment, as stated before, having a pure color.



VIGNETTED HALF-TONE—133-LINE SCREEN.

With tint background.

during exposure by means of a properly dyed color filter. We can then make from any colored object three negatives, one of which shall have been affected by the red rays, one by the green and one by the blue-violet. If, then, three printing plates are made corresponding to these negatives and printed in pigments of complementary colors, the images being properly superposed, the result will be a reproduction in the colors of the original. Inks complementary in color are used because, to produce the desired effect, there must be absorbed from the white paper such primary rays as the original absorbed from the white light which illuminated it, which will cause the proper rays to be reflected to reproduce the colors of the original. The quantity of the respective colors reflected from the image will be equal in quantity to those reflected from the original when the quantity absorbed by the pigments from the white ground is equal to the quantity absorbed from the light by the original.

Blue of the proper shade will absorb red, red will absorb green, and yellow will absorb blue. The printing plate corresponding to the "red negative" must be printed in blue, to the "green negative" in red, and to the "blue negative" in yellow.

The inks must, of course, be sufficiently transparent to allow the passage of the proper rays.*

* Discrimination must, of course, be used in the selection of inks of the proper shades. Of two pigments, for instance, both may be said to be blue, and one have much greater red-absorbing properties than the other.

To obtain any one of these negatives the coating of the plate must be sensitive to those rays by which it is to be affected, and the other rays to which it will also be sensitive must be excluded by means of a color filter.

For the "blue-violet negative," corresponding to the yellow-printing plate, an ordinary gelatino-bromide plate may be used with a methyl violet filter, which will prevent the action of the ultra-violet rays which would interfere with the rendering of the true color values.

For the "green negative" (red-printing plate), the orthochromatic (erythrosine-cyanine) plates as prepared by dry-plate makers may be used with a strong yellow filter, which will allow the green rays to pass and cut out the blue-violet.

The "red negative" (blue-printing plate) may be made with an ordinary plate treated with cyanine, which renders the plate sensitive to all rays except green. The cyanine solution may be made by dissolving ten grains cyanine C. P. in twenty ounces alcohol. The plate is dipped in this for twenty or thirty seconds, rinsed in distilled water, and dried in the dark. Any filter may be used which will exclude blue-violet rays and admit the red. Crysoidine orange will give good results.

Plates sensitized with cyanine are extremely liable to fog and must be developed in almost darkness.

In making any of the color negatives, exposure and development must be correct or the color values will not be rendered properly.

The color filters must be correct, and their qualities should be determined by examination with the spectroscope, which shows the colors transmitted. They may be made by coloring collodion or gelatine and coating glass with it, or by placing a colored solution in a glass cell. The glass plates must have their sides parallel and free from irregularities or a blurred image will result. The color screen may be placed in front of the lens or at the back, the latter position being generally preferred.

Having obtained the three negatives, the next step is to make from them three corresponding positives, which may be made on either gelatine or collodion plates, care being taken to not make the positives too intense.

During the operations of making the negatives and also the positives the camera must be firmly fastened that no movement whatever shall occur, for the slightest variation will render useless results.

The positives must now be placed so that the half-tone negatives for the printing plates can be made from them by transmitted light, the camera as before being fixed to avoid any movement. The form of the diaphragm aperture is an important consideration in making these negatives. If the round or square aperture, such as used for ordinary work, be employed, it is evident that the superposition of the images from the printing plates would result in a moiré effect; but if apertures of such a form be employed as will give in each case, an effect, not of cross lines, but of a

single set of parallel lines which when superposed will cross the lines of the other images at the proper angle, the moiré effect will be avoided. In a preceding chapter it was stated that the form of aperture determined the shape of the dot in the negative. If a slot-shaped aperture is used, its sides being parallel to one of the sets of lines of the screen, the resulting negative will be made up of continuous lines running in one direction, due to the joining of the images of the aperture; but if the aperture be broadened in the middle so as to have an elliptical form, the negative will be made up of similarly shaped dots in the lighter portions, the dots being ranged in parallel lines and joining to form solid lines in the shadows. With the use of properly shaped apertures in the diaphragms we have a means, therefore, for obtaining proper effects with a cross-line screen.

To cause the lines of the negative to run at the desired angle in each case, the kit for holding the positives may be arranged to revolve through any number of degrees as required. The positives are then placed successively in the kit and turned as required to sixty degrees for the exposure. If the positives are properly placed as regards right and left, it will not, of course, be necessary to reverse the negatives.

An examination of the color plates will show the forms of the elements and their proper relation to each other.

The operations should be so carried out that the printing plates shall have quite open high lights,



ZINC ETCHING—WITH GRAIN EFFECT.

Drawn by Fred Richardson.

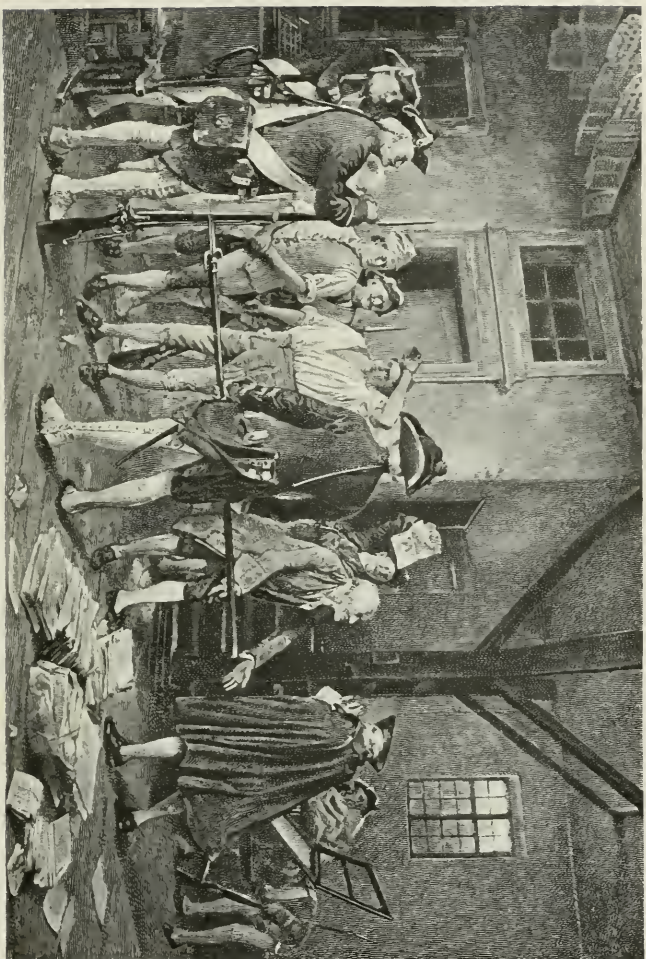
any parts which are desired to appear extra light being corrected with the tool. Perfect register is essential in printing these plates to obtain correct results. The yellow is printed first, the red superposed next, and the blue last. Plates mounted on metal bases give much better results in printing than if mounted on wood.

CHAPTER XV.

PRINTING HALF-TONE PLATES.

PHOTO - MECHANICAL engraved printing plates have largely revolutionized pressroom theories, and owing to the shallowness of the engraving and to the greater necessity of dependence on the qualities of paper and ink, the judgment and skill of the pressman is more than ever before required to give life and brilliancy to cut work. Unevenness in half-tone plates is a source of much annoyance to the pressman. All plates should be made perfectly level before etching and the greatest uniformity should be observed in the grinding and polishing.

The following instructions for preparing half-tone plates for printing obtains in one of the large establishments of America noted for the quality of the half-tone work produced. Obtain all the cuts on a certain piece of work from the composing room before they are made up in the forms, and of each cut have proofs taken on three different weights of paper—24 by 36, 60, 70 and 80 pounds—and then proceed to make cut underlays. Taking one of the proofs on the 70-pound stock, carefully trim it all around, leaving a margin of one-sixteenth of an inch of blank all around the print.



HALF-TONE WITH WOOD-ENGRAVED EFFECT.

Made from photographure print.

Then cut out of the sheet all of the extreme high lights, being careful to cut a little of the surrounding shadows with them, the purpose of this being to prevent too much impression on the point of division, which would have a tendency to bring up the shallows. Then take a proof on the 80-pound stock and remove from it the extreme blacks and solids—always cutting a little inside the line—and paste them on the 70-pound sheet already treated, using common flour paste or mucilage. Then take one of the proofs on 60-pound stock and cut out all of the intermediate shades such as should appear lighter or softer in the finished print. Take these several proofs and paste them together, and this would be called a four-ply cut overlay, excepting that all of the pieces comprising it are cut a trifle inside of the line. If the cut has more shade in it than can be properly treated with three sheets, take a 50-pound paper in place of the 60-pound and add one sheet to the underlay, treating it in the same way as the second sheet with the exception that instead of cutting out the extreme solids remove all the semi-dark shades as well and paste them on. Having made the underlays in the manner described, proceed to unmount the cuts from their bases. In order to do this without injuring or scratching them great care is required. The tools which will be found to be the most advantageous are a small hammer, a pair of pliers, and a small chisel—this last should be about a quarter of an inch in diameter at the shank and should have a long tapering blade, and be about half an inch

wide at the extremity of the blade. Some small wire brads, such as are commonly used for mounting the plates, a prick punch, a small nail set, an electrotyper's iron finishing plate, and a pair of plate calipers such as are used by electrotypers, are the other requisites. Having removed the plate from the block, take the calipers and mark at least two distinct points on the back of the plate in order to be able to paste the underlay accurately in position. This done, lay the cut face up on the iron plate and with a small boxwood planer go over the entire surface, taking care to strike only a moderate blow. Take the block thereafter, and examine it carefully to see that it is free from lumps and rough places and mount the cut on the opposite side to that from which it was taken and send it to the composing room.

This method saves a great deal of time in the final make-ready of the form, as it is only necessary to even up the impression on the cut, and the underlay will throw the lights and shades where they should be without any further care on the part of the pressman, and for long runs will preserve the cut much better than if a plan of overlaying was followed. It holds up to the rollers the dark parts of the cut, properly supplying them with ink and protecting the lighter and more delicate shades from receiving unnecessary pressure.

. The practice of many pressmen who obtain good results is to even up the cut by underlays, and then proceed to make such overlays as the character of the work will indicate to be the most suitable. To

be successful in making any kind of an overlay as little paste as possible should be used, only sufficient to compactly bind together the different portions of the overlay, and to register each piece of paper over the other with positive accuracy. For work of differing character the papers used in overlays vary. Impressions of the cuts are taken, for instance, on three grades of stock: One sheet, say of 10-pound folio, one of double that thickness of supercalendered, and one sheet of the stock upon which the cut is to be printed. Sometimes the last sheet mentioned is selected for the first treatment, which consists in cutting away from it any large, light backgrounds, and scraping down and slitting off many of the light and medium tones, so as to throw up the stronger ones and the solids. A sharp knife and some degree of skill is necessary to handle a sheet of paper in this way, but it is worth one's while to acquire it, for it saves time and much pasting on of parts of overlays, besides giving a firmer basis.

The sheet of supercalendered stock may now be taken, and from it should be cut all the light tints as well as some of the stronger ones. The sheet is also used as the foundation on which to paste the cut-out portions of the two other sheets.

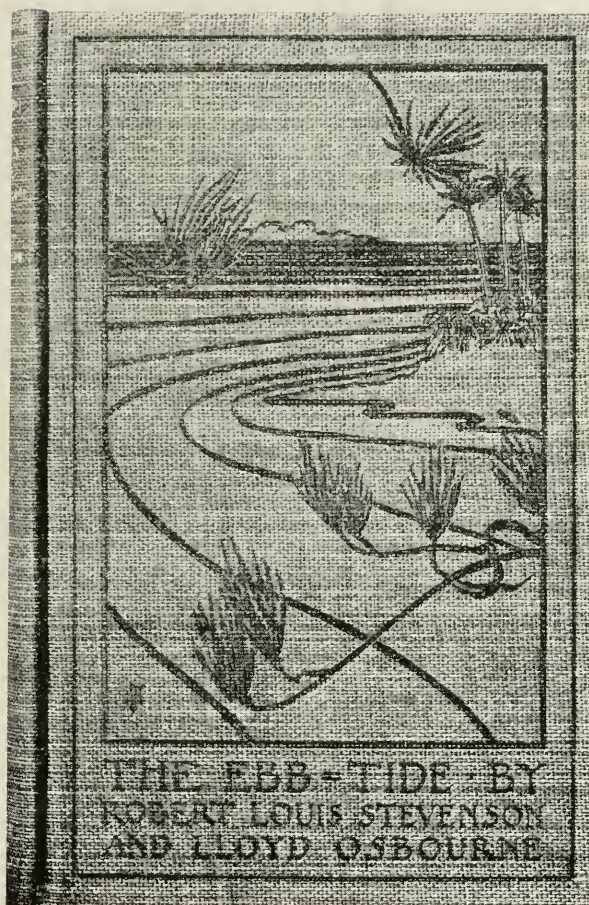
The third sheet of thin folio should be used to make overlays for such portions of strong solids and shades as require them. These should be pasted accurately in place on the supercalendered sheet, and over them should be fastened the first sheet treated. From this arrangement it will be

apparent that the first sheet, the folio and the supercalendered sheets press on the form in the order named, and in their relative degree of pressures.

WHY PLATES FILL UP WITH PICKS.

This comes from several causes, usually unsuitable rollers or rollers not set light enough to properly roll the delicate plate surfaces, and rollers not cast true in the stocks. Inks that are too stiff or too thin, or not sufficiently ground, or ground in inferior oil or varnish, will also cause this trouble. Washing the plates with either woolen or cotton rags forces into the sharp openings of the half-tone the flock from the rags, and this also causes "picks." Half-tone work should be washed with a good brush of medium fineness, and a clean cotton rag should be used to lightly sponge up the washing fluid—be it benzine, astral oil or turpentine. In no case should rags alone be used to clean these plates, nor should anything be carelessly, harshly or hurriedly rubbed over their surfaces.

Defective coating on enameled paper, or what is known as surfaced wood-cut paper, will produce picks and fill-ups on half-tone plates; and in such cases an ink with a very slight tack should be used to get fair working results; but the form should be washed off oftener than when better stock is running. After making ready, and between long stops, half-tone plates should be thoroughly cleaned off, as by so doing clearer and more satisfactory work can be turned out.



HALF-TONE MADE DIRECT FROM BOOK COVER.

COLORS FOR HALF-TONE PRINTING.*

In every child's storehouse are treasured many bits of color. This love of color, inborn, may always be made of strong appeal. The profusion of illustration constitutes one of the greatest influences in every grade of publication—commercial, scientific and literary. The form and detail being fixed by the subjects concerned, it remains only to print them in such quality and strength of color as shall be best. Since the greater portion of printing is confined to one color, this article is limited to printing in monotoness.

Fitness to the subjects themselves controls the choice of some colors. Figures, particularly nudes, require warm tones. It is not customary, however, to be restricted to such monotoness as approach flesh tints. Browns, deep reds and rich olives are all good. Marines are the most limited in range of color, greens and blues being generally used. Landscapes allow more license in color, all of the autumnal tints being possibilities.

Next to the subjects, the purposes and uses of the print must be regarded. For permanent value, simplicity of effect is of more importance than any striking contrasts which will, in time, prove a detraction. The plain catalogue page is made attractive by some monotone which is at once decorative and an approach to the true color of the subject. Commercial printing, such as catalogues

*From an article by Mr. Henry Lewis Johnson in *The Inland Printer* the above suggestive notes on colors for half-tone printing are taken by special permission.

and placards, admits of stronger colors than are used in bound volumes, purely illustrative. The practical value of a catalogue illustration often requires that all of the details be clearly shown, and dark colors are necessary for this. In art catalogues the reverse is found; everything is sacrificed to effect.

Black always shows the full strength and brilliancy of an engraving. Colors which approach black in density possess most brilliancy and detail. Browns, although good, are open to some prejudice, since for many years they have been used on every fine programme, catalogue and specimen print. An order for a "fancy job" has been synonymous with brown ink. This color has one practical advantage. Where the same plates are used, year after year, in catalogues, they become necessarily somewhat worn and battered. These defects are largely obscured by this neutral color.

Blues are not much used in half-tone printing. In their use all of the lights, which give contrast and brilliancy to a picture, are lost. It is naturally a color seldom used for landscapes. The slow drying qualities of the ink are an objection to its use on programmes or any work which has to be bound soon after printing. Blue-black, of the darkest shades, is being largely used, giving marked brilliancy to the print.

Reds, in the richer carmine shades, are effective but somewhat costly. They are difficult colors to handle well, requiring very exact gradations to avoid being crude. Yellow has some important



ZINC ETCHING — INTENSE BLACK AND WHITE EFFECT.

Drawn by J. C. Leyendecker.

uses. Deep corn yellow is preferable to the canary shade. Greens are good and are in great favor at the present. Particularly rich effects are obtained in deep shades of olive, yielding strength and warmth. Such prints closely approach photogravures in effect, having strength yet obscuring the half-tone lines. Instead of primary browns, blues and greens, each one is better for ordinary purposes as it approaches black.

For the printer there is a practical, and, indeed, economical side to the use of colored inks. By using the engraver's proof in black in making ready, the print may be brought up to its proper condition. The element of "rush" usually enters in at this stage. Justice cannot be done to the cuts in black, in long, hurried runs, as it is difficult to maintain the color. A slight variation in the brilliancy of the print in an olive or brown does not constitute the defect which it would in black. In place of strained effects in descriptive lines and text, the monotone is the desired decoration.

The use of monotoes is an interesting and a critical part of the work. For the simplest print the requirements of color are exacting, and, successfully handled, constitute a step in advance in the art of printing.

APPENDIX.

TABLES OF WEIGHTS AND MEASURES— INFORMATION FROM VARIOUS SOURCES.

MEASURES.

LINEAL.

Mile.	Rods.	Yards.	Feet.	Inches.
1 =	320 =	1760 =	5280 =	63360
	1 =	5 $\frac{1}{2}$ =	16 $\frac{1}{2}$ =	198
		1 =	3 =	36
			1 =	12

SURFACE.

Acre.	Roods.	Sq. Rods.	Sq. Yds.	Sq. Ft.
1 =	2560 =	102400 =	3097600 =	27878400
	1 =	160 =	4840 =	43560
		1 =	30 $\frac{1}{4}$ =	272 $\frac{1}{4}$
			1 =	9

VOLUME.

Gallon.	Quarts.	Pints.	Gills.	Cubic Inches.
1 =	4 =	8 =	32 =	231
	1 =	2 =	16 =	
		1 =	4 =	

FLUIDS.

Gallon.	Pints.	Ounces.	Drams.	Minims.	Cubic Centim's.
1 =	8 =	128 =	1024 =	61440 =	3785435
	1 =	16 =	128 =	7680 =	473179
		1 =	8 =	480 =	29574
			1 =	60 =	3697

WEIGHTS.

TROY.

Pound.	Ounces.	Pennyweight.	Grains.	Grams.
1 =	12 =	240 =	5760 =	373.24
	1 =	20 =	480 =	31.10
		1 =	24 =	1.56

APOTHECARIES'.

Pound.	Ounces.	Drams.	Scruples.	Grains.	Grams.
1 =	12 =	96 =	288 =	5760 =	373.24
	1 =	8 =	24 =	480 =	31.10
		1 =	3 =	60 =	3.89
			1 =	20 =	1.30
				1 =	.06

AVOIRDUPOIS.

Pound.	Ounces.	Drams.	Grains.
1 =	16 =	256 =	453.60
	1 =	16 =	28.35
		1 =	1.77

1 gram = 15.43 grains = .03215 troy ounces = .03527 avoirdupois ounces.

1 grain = .0648 grams.

1 pound avoirdupois = $1\frac{31}{44}$ pounds troy = $1\frac{31}{44}$ pounds apothecaries'.

1 ounce avoirdupois = $1\frac{75}{92}$ ounces troy = $1\frac{75}{92}$ ounces apothecaries'.

1 pound troy = 1 pound apothecaries'.

1 ounce " = 1 ounce "

1 grain " = 1 grain "

1 pennyweight " = $\frac{2}{5}$ dram "

TO PREPARE PERCENTAGE SOLUTIONS.

For each fluid ounce of water take of the salt 4.557 grains to make a 1 per cent solution, twice the amount for a 2 per cent solution, etc.

When stated in parts per 1,000, etc., for each fluid ounce of water take of the salt 0.4557 to make 1 part in 1,000, twice

the amount to make 1 part in 500, ten times the amount to make 1 part in 100, etc.

PRINTING METHODS.

BLUE PRINTS—WHITE LINES ON BLUE GROUND.

1. Citrate of iron and ammonia..... 1 ounce
Water 4 ounces
2. Red prussiate of potassium..... 1 ounce
Water 4 ounces

Dissolve and mix the two solutions, coat the paper with sponge or absorbent cotton wet with solution, dry in dark and print under negative until details are visible. Then develop by washing under tap.

It is stated that blue prints may be bleached by a very dilute solution of potassium carbonate and potassium hydrate, after which they should be flowed with dilute hydrochloric acid and washed. This being the case, they may be used similar to silver prints, as described in Chapter XIII.

BLUE LINES ON WHITE GROUND.

Gum arabic.....	385 grains
Sodium chloride.....	46 grains
Tartaric acid.....	62 grains
Perchloride iron.....	123 grains
Water.....	3½ grains

Coat paper and dry in dark. After exposure, develop in saturated solution of potassium ferrocyanide. Fix in 1 to 20 solution of hydrochloric acid. Wash.

BLACK LINES ON WHITE GROUND.

Oxalic acid.....	5 grains
Ferric chloride.....	10 grains
Water.....	3 ounces

After printing, develop in 15 per cent solution of ferrocyanide of potassium; wash and fix in 10 per cent solution of hydrochloric acid. Wash.

ANOTHER PROCESS.

Water.....	300 cu. centim's
Gelatin	10 grams
Ferric chloride, in thick solution	20 cu. centim's
Tartaric acid.....	10 grams
Ferric sulphate	10 grams

When paper is dry, expose under negative and develop in

Gallic acid.....	20 grams
Alcohol	200 cu. centim's
Water.....	1 liter

and wash.

VARNISHES.

VARNISH FOR COLLODION NEGATIVES.

Water	30 ounces
Borax	1½ ounces
White shellac.....	4 ounces
Glycerine.....	¼ ounce

Dissolve the borax in the water, then add the shellac and warm the water, keeping it so until the shellac is dissolved, then add the glycerine.

DEAD BLACK VARNISH.

Gum lac	30 grams
Alcohol	200 cu. centim's

Dissolve.

Lampblack	60 grams
Alcohol	40 cu. centim's

Dissolve and add to the gum solution.

PLAIN PHOTOGRAPHIC PAPER.

It is an easy matter to prepare one's own paper and it will keep for any length of time. All that is necessary is to use a good quality linen paper and soak it in a weak sizing of gelatin containing a chloride salt, so that when applying nitrate of silver afterward to this paper a chloride of silver will be formed. The following is an excellent formula: Take a smooth linen paper if it is to be used for pen-and-ink work, or a rough paper like Whatman's drawing paper if for wash work, and immerse it in a warm solution of the following:

Water	1 ounce
Gelatin	12 grains
Chloride of ammonium.....	8 grains

When the paper is soaked with this liquid hang it up to dry. It will keep indefinitely. To sensitize this paper use:

Water	1 ounce
Nitrate of silver	50 grains
Nitric acid	15 grains

CLEARING SOLUTION FOR HALF-TONE
NEGATIVES.

Engravers having trouble with negatives filling up in the intensifying will find a clearing solution of great value. Properly used, it is one of the most valuable aids in securing perfect half-tone negatives. There are two ways of using this clearing solution. The first is to prepare an iodine solution:

Iodine in flakes.....	10 grains
Iodide of potassium	10 grains
Water	1 ounce

After the negative is intensified with bromide of copper and nitrate of silver as usual, it should be examined with a magnifying glass to determine how much clearing is necessary. Then flow over the negative the iodine solution until



HALF-TONE—133-LINE SCREEN—HAND-TOOLED.
From wash drawing by Louis Branahold.

it has permeated through the film, wash well, leave the water running, and flow over the iodized plate a very weak solution of cyanide of potassium. If it should appear to clear the negative too quickly, thrust the negative immediately under the running water. After washing examine with the glass again, and proceed or stop clearing as judgment warrants. The majority of operators add cyanide solution to the iodine solution until the latter becomes clear as water, and use it then as the clearing solution.

TWO SUGGESTIONS FOR DESIGNERS.

Wall paper of neat design may sometimes be used as a background for a group of photographs to be reproduced in half-tone, giving a better appearance than a plain ground, and allowing the time of an artist to design a ground to be saved. Good effects can also be obtained in some cases by spreading glue over certain portions of a design and sprinkling over the wet glue chips of metal from the router or trimmer.

ETCHED EMBOSSING PLATES.

Plates for embossing can be made quite readily by zinc etching, as follows: From the relief plate take an impression with black ink on thin white paper, as nearly transparent and tough as can be obtained. Then dust over the wet ink very finely powdered graphite or other opaque powder to render the ink still more impervious to light. Coat a thick zinc plate with the sensitive albumen solution, place the paper in contact with it, insert in printing frame and expose in same manner as with a negative. Then roll up and develop as usual and the result will be an image having the letters or design of exposed zinc with a ground of transfer ink. The plate is then etched in the usual manner, care being taken to protect the edges of the design from breaking. If the relief plate is not at hand, make a negative of the design and from this a positive, and use the positive to obtain the print upon the zinc. To make the

positive, place the negative in the kit in front of the copying camera, having the lens in the kit inside. Fasten a sheet of white paper to the copy board and move the ground glass until the image measures exactly the proper dimensions, then proceed as in making an ordinary negative. A method simpler than the above would be to transfer the image from the relief plate to the zinc by means of the press, paint in the ground well with transfer ink, and etch.

A SUBSTITUTE FOR GROUND GLASS.

There is scarcely any accident more aggravating to the photo-engraver than the breaking of the camera ground glass. As it is of frequent occurrence and it is difficult to obtain glass ground fine enough for the purpose, it behooves the photographer to be provided with the following varnish which furnishes an excellent substitute for ground glass:

Sulphuric ether	4 ounces
Benzole	2 ounces
Alcohol	$\frac{1}{2}$ ounce
Gum sandarac or damar.....	100 to 150 grains

If too much alcohol is used it will give a transparent instead of a ground glass effect. Flow this varnish on a sheet of plain glass like collodion. It dries quickly and without heat, and should give an excellent imitation of ground glass. In passing it might be said that if a little glycerin is rubbed into the grain of an ordinary ground glass it renders it much easier to focus on. It is best to rub it over but a portion of the ground glass, say a strip from the center to one edge.

PROVING COLOR PLATES.

Mr. J. H. Siedenburgh, of New York, says *The Inland Printer*, has devised the following method of proving color plates: In a worthless piece of zinc, say 10 by 12 in size, $\frac{1}{32}$ -inch holes are drilled in diagonal corners. Short pieces of a steel needle are driven into these holes and soldered



COMBINATION OF LINE AND HALF-TONE, ETCHED
TOGETHER ON ZINC.

...al America; no ... in this country
... on any British plans for the acquisition
of Hawaii."

THE INLAND PRINTER.

The April number of the Inland Printer leads off with a cool and discriminating review of the work of Aubrey Beardsley, the new eccentric illustrator. Mr. Way, the critic, rightly distinguishes Beardsley's work as decoration, like that of the Japanese, rather than illustration. There are articles on "Recent Type Designs," "Colored Ink Fountains for Printing Presses," "Advantages of Type-Written Copy," and a score of other subjects in which printers take delight, besides less technical studies devoted to the æsthetic side of book-making, and a profusion of the best selected and most handsomely printed full-page and marginal engravings.

Boston Daily Traveller, Apr. 10.
BOOKS RECEIVED.

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HALF-TONE REPRODUCTION OF TYPE-MATTER.

there, after which the upper ends of the needles are filed to sharp points. This he calls the "ground plate." After photographing and etching the color plates, one of them is taken and clamped securely to the center of the ground plate; $\frac{1}{32}$ -inch holes are drilled through the regular registry points, which were, of course, on the copy and photographed on each plate. These holes are bored through both the color plate and the ground plate. Now two blocking brads about $\frac{1}{32}$ -inch thick are driven through the ground plate holes from the back and cut off to height of thickness of color plate. With nail set, punch the metal around the brads to hold them rigid. When $\frac{1}{32}$ -inch holes are bored in the center of the registry points in the other color plates they are all ready for proving. When the first color plate is proved, the needle points in the ground plate puncture holes in the proof, which are used to register the paper in the subsequent printings, while the steel brads keep the plates in register.

TO CHANGE THE READING ON ONE THERMOMETER SCALE TO THAT ON ANOTHER.

Fahrenheit to Centigrade.— Subtract 32 from the Fahrenheit reading and multiply the result by $\frac{5}{9}$.

Fahrenheit to Réaumur.— Subtract 32 from Fahrenheit reading and multiply result by $\frac{4}{9}$.

Centigrade to Fahrenheit.— Multiply Centigrade reading by $\frac{9}{5}$ and add 32 to the result.

Centigrade to Réaumur.— Multiply the Centigrade reading by $\frac{4}{5}$.

Réaumur to Fahrenheit.— Multiply the Réaumur reading by $\frac{9}{4}$ and add 32.

Réaumur to Centigrade.— Multiply the Réaumur reading by $\frac{5}{4}$.

The Inland Printer.



What it is.

THE INLAND PRINTER is a monthly magazine of from 100 to 120 pages, 9 by 12 inches in size, devoted to printing, publishing, engraving, electrotyping, stereotyping, bookbinding, papermaking and all the kindred trades. It is a work of art, and should be in the hands of every lover of the typographic art or anyone interested in newspaper work or advertising. Issued promptly on the first of every month. Subscriptions can begin with any number.

What it Contains.

Its pages are filled with the most instructive and interesting original articles relating to the matters that properly come within its domain, besides an amount of valuable data, trade topics, correspondence, craft items, recent patents, recipes, hints and suggestions that will surprise you. In addition to this, it is copiously illustrated, and the whole makeup and general character of the work is such as to challenge admiration.

The Illustrations. The full page illustrations and those worked in with the text are all of a high order, and include half-tone, zinc etching and other methods of engraving, alike valuable to the engraver, process-worker, compositor and pressman. Colored plates, by various processes, are also shown.

The Text. Taking up a copy at random one finds articles on proofreading, the point system in type founding, notes on bookbinding, natural colors in the printing press, newspapers and newspaper men, the country newspaper, typographical make-ready, advertising, convention notes, review of type designs, pressroom queries and answers, process engraving, new patents, trade notes and much general information.

The Advertisements. These are as important in a way as any other part of THE INLAND PRINTER, for the reason that they are set in attractive and catchy style, alike beneficial to the compositor and "ad." writer, and printed in the same excellent way that the other part of the journal is. This part will interest you as well as the text.

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